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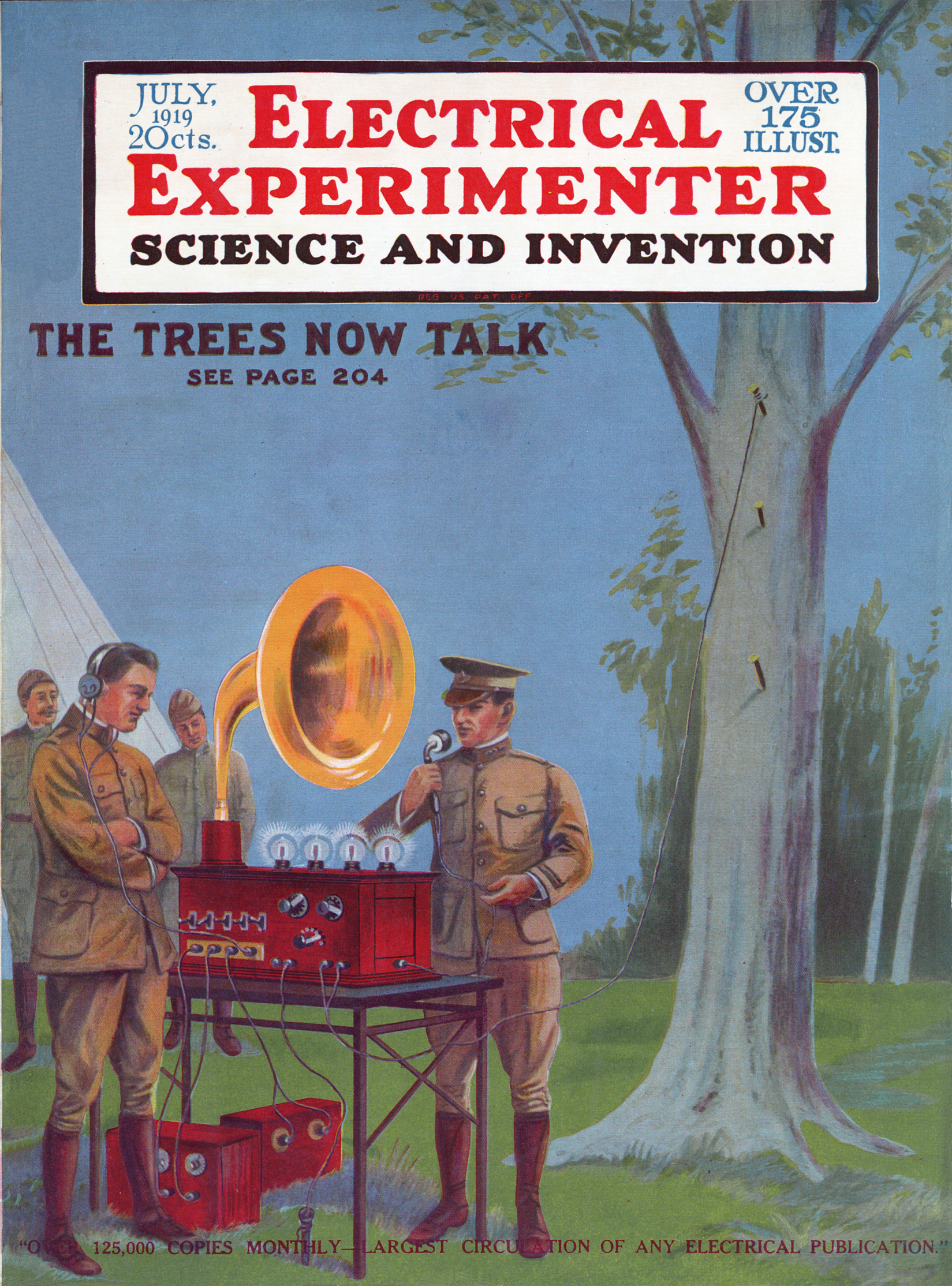

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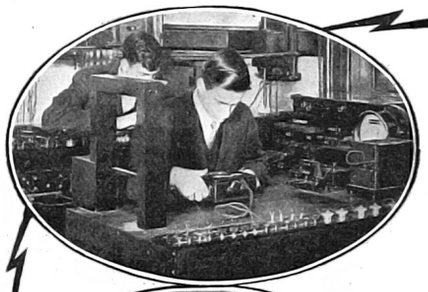

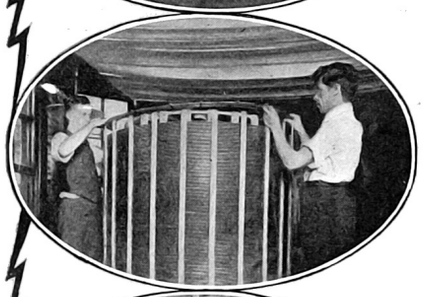

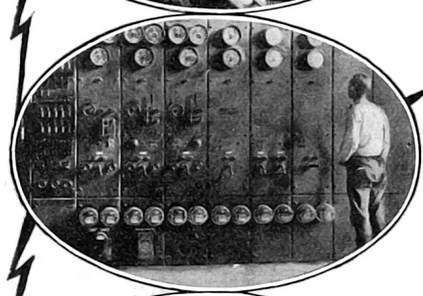

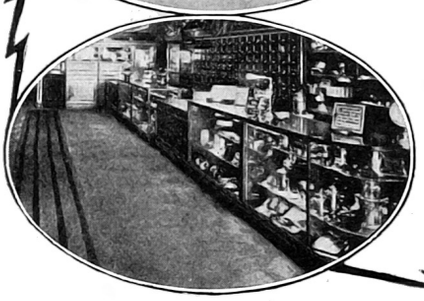

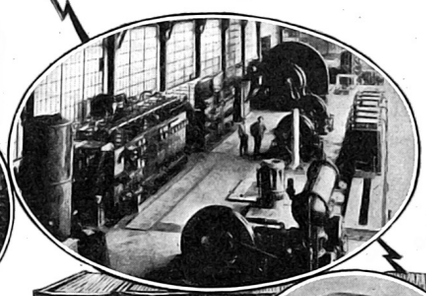

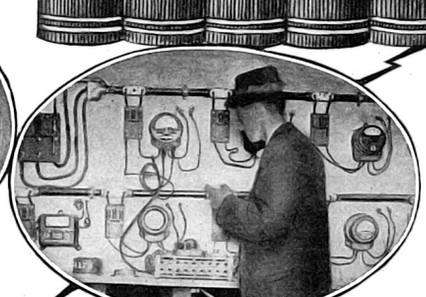

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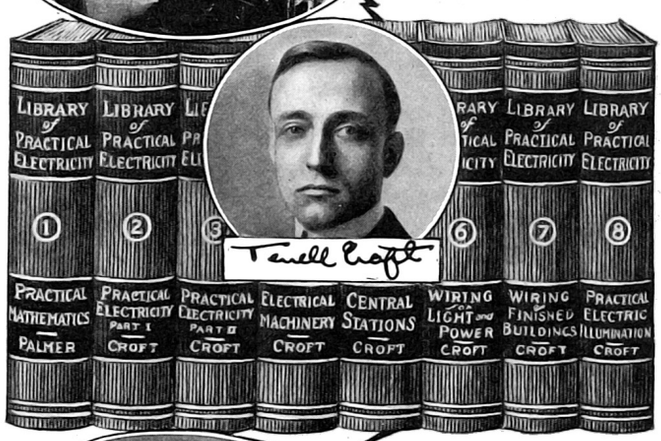

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EDITORIAL

Piped Cold

ONE of the most profound annual summer mysteries of the twentieth century—at least to the writer—is our hot office or our hot home. We would not think of an uner heated house or office in the dead of winter with the temperature near the zero point, but curiously enough we allow ourselves to suffer cruelly from the heat in the summer time when the temperature rages up in the nineties. Is it not a most curious world in which we live?

We think nothing of spending fabulous sums in the winter for our coal supply in order to keep warm and comfortable. But in the summer we prefer to spend nothing and suffer untold misery in consequence. Babies and grown up sick folk die like flies by the thousands on account of the heat, while we stand by helpless, or rather as if we were devoid of all intelligence, while the totally unnecessary slaughter goes on incessantly. How our grandchildren will read with astonishment that for decades human beings had their houses piped for heat, but had not enough sense to run a freezing solution or other freezing agent thru the self-same pipes in the torrid summer days!

There might be an excuse for our criminal negligence if we had not the means at hand to keep us cool and comfortable in summer. But we really have all the means, all the apparatus; in fact, everything—including our radiators and pipes. But we prefer not only to let our babies and our feeble old folk die unnecessarily every summer, but we actually lose untold millions of dollars thru non-production when the "dog-days" are upon us. No one can work at his best when the mercury climbs to dizzy heights. Production, whether mental or physical, slows down anywhere between forty and eighty per cent. Statistics prove it. Factories as well as offices slow down and just barely creep along. Think of this enormous, incalculable loss alone, not to mention all the physical suffering due to the heat.

Ah, yes, we *do* have our brave fans—which, however, do not cool at all, but only remind us how hot our bodies are the minute we are not in the immediate vicinity of one of these spinning monuments to our stupidity.

For our dear fans only stir up the hot air *and* the dust. Our skin, wet or moist from perspiration, meets this stirred up air and due to a well known physical phenomenon, *surface evaporation,* we experience a *sense of coolness,* but the air itself is *not* cooled. It is true that surface evaporation produces cold, but in order to have it, it is necessary to let the fans blow upon us, or nearly so, and everyone knows this is far from healthy, frequently producing severe colds. Besides, as soon as we leave the fan our suffering from the heat is all the more acute.

Where is the practical genius who will "study up" on refrigeration and sell us a cheap refrigerating machine which we can connect to our already existing steam or hot water radiators? For the same money which we now spend on fans we ought to be able to buy the machine. And for the money it costs to run the fans we can run the refrigerator, too.

Hundreds of refrigerators have been invented, but the simplest and best no doubt for our purpose is the *cold-air process.* It is based on the principle that the compression of air generates heat and in its subsequent expansion absorbs heat. The air is first comprest, is then past thru a cooler under pressure, after which it is expanded in a cylinder. No chemicals are used with this system and it possesses the very distinct advantage that extremely low temperatures are readily obtainable.

H. GERNSBACK.

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Member of the Audit Bureau of Circulation.

El Paso, Texas, Oct. 1, 1917.
MR. CHARLES F. HAANEL, St. Louis, Mo.
In Re "The Master Key."

My Dear Mr. Haanel: The value of an idea is determined by its application. Pragmatism has long since spread beyond the confines of Missouri. The world to-day insists on being shown.

The lash of circumstances and the logic of events are, more than ever, impelling men to think. Whether an idea be a new process for picking cabbages, or an old process (Kaiserism, for instance) for preserving kings, we are from Missouri.

A philosophy of life having as its base blind optimism; a religion that won't work seven days a week, or a proposition that isn't practical, appeals to the intelligent not at all. It is results that we want and the acid test is: will it work?

The Master Key qualifies. It is the most lucidly scientific statement of "Truth" that I have seen. It reconciles rationalism and religion; illumines economic determinism and the materialistic conception of history, and is an infallible guide to understanding. It contains in condensed form the substance of an entire library on science. Its teaching, if consistently applied, will make a man healthy, wealthy and wise. Its distribution is supermissionary work in excelsis. Those who wish to think intelligently will find it invaluable.

Intelligence rules. Desire, intelligently directed, is a creative force which automatically causes its object to manifest on a material plane. It is the law. Let him that hath an ear to hear, hear.

Yours truly,
CHAS. A. HEARD.

May 15, 1918.

DEAR MR. HAANEL: Ever since I have been old enough to read, I have been reading metaphysical literature. I have waded ears deep through the books from all ages, all lands, all schools.

I have rejected tons of lies, oceans of misconceptions, an entire universe of false deductions.

I have found grains of truth in mines of folly, and worlds of truth in a single grain. The pursuit was interesting in itself, and I do not regret the time spent upon it. But it was a genuine surprise to read your Master Key System and find within, the essence of all that I had read, with much more added thereto.

In this extraordinary system you have sifted the true from the false; you have given in concrete form all that is worth while in many schools of philosophy.

You have placed arcane truths into the hands of the uninitiated as weapons they can learn to use without danger to themselves. I congratulate you. You are doing mankind a service.

Yours very sincerely,
CHARLES F. OURSLER.
501 Fifth Avenue, New York City, N. Y.

Detroit, Mich., May 28, 1917.

DEAR SIR: The words, "Your world will change as if by magic, the moment you realize the marvelous power within your control," page 6, I have underlined. They state a fact, a real live fact; and to me this is the most wonderful, the most important fact of all—that one may put this knowledge to an immediate test, that one may, after learning of this power, proceed to apply it with a definite knowledge as to results.

W. M. HOWE.

THE LOWE OBSERVATORY
Edgar Lucien Larkin, Director
Los Angeles, Cal., Dec. 6, 1916.
MR. CHAS. F. HAANEL, St. Louis, Mo.

DEAR SIR: Your booklet, Master Key, ought to be expanded into a book. Its teachings that Mind is the all-dominating creative force is precisely in line with the wonders of the most recent psychology. All persons having desks should have this pamphlet thereon. And it would be a fitting pocket companion.

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"The Master Key" is a key with which many are converting loss into gain, fear into courage, despair into joy, hope into fruition; a key with which many are finding health, self-reliance, power; a key which thrills, fascinates, carries conviction, understanding, perception, inspiration, the key which is changing the lives of many and may have an almost unbelievable influence upon your life.

Charles F. Haanel, 423 Granite Bldg., St. Louis, Mo.

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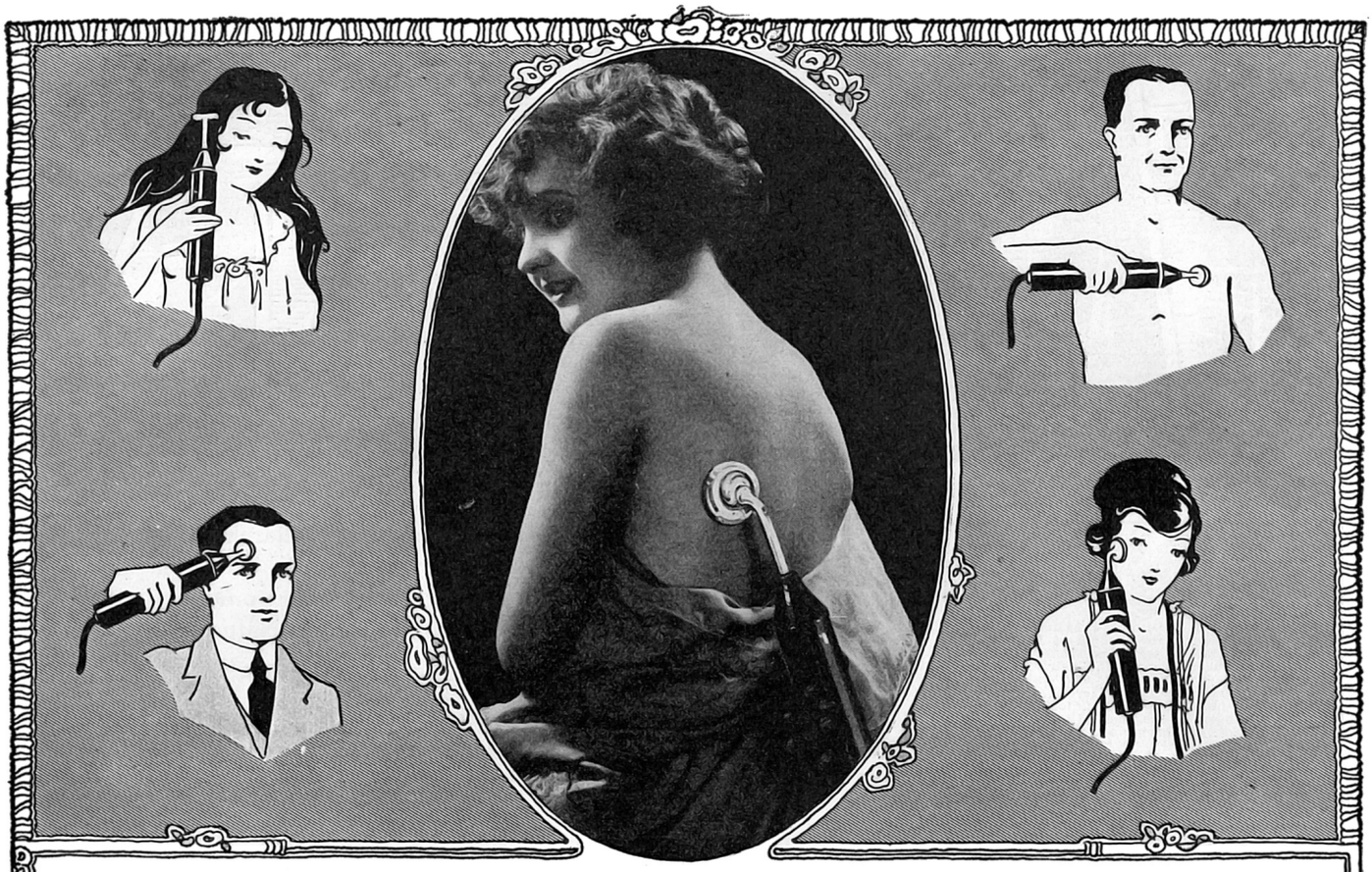

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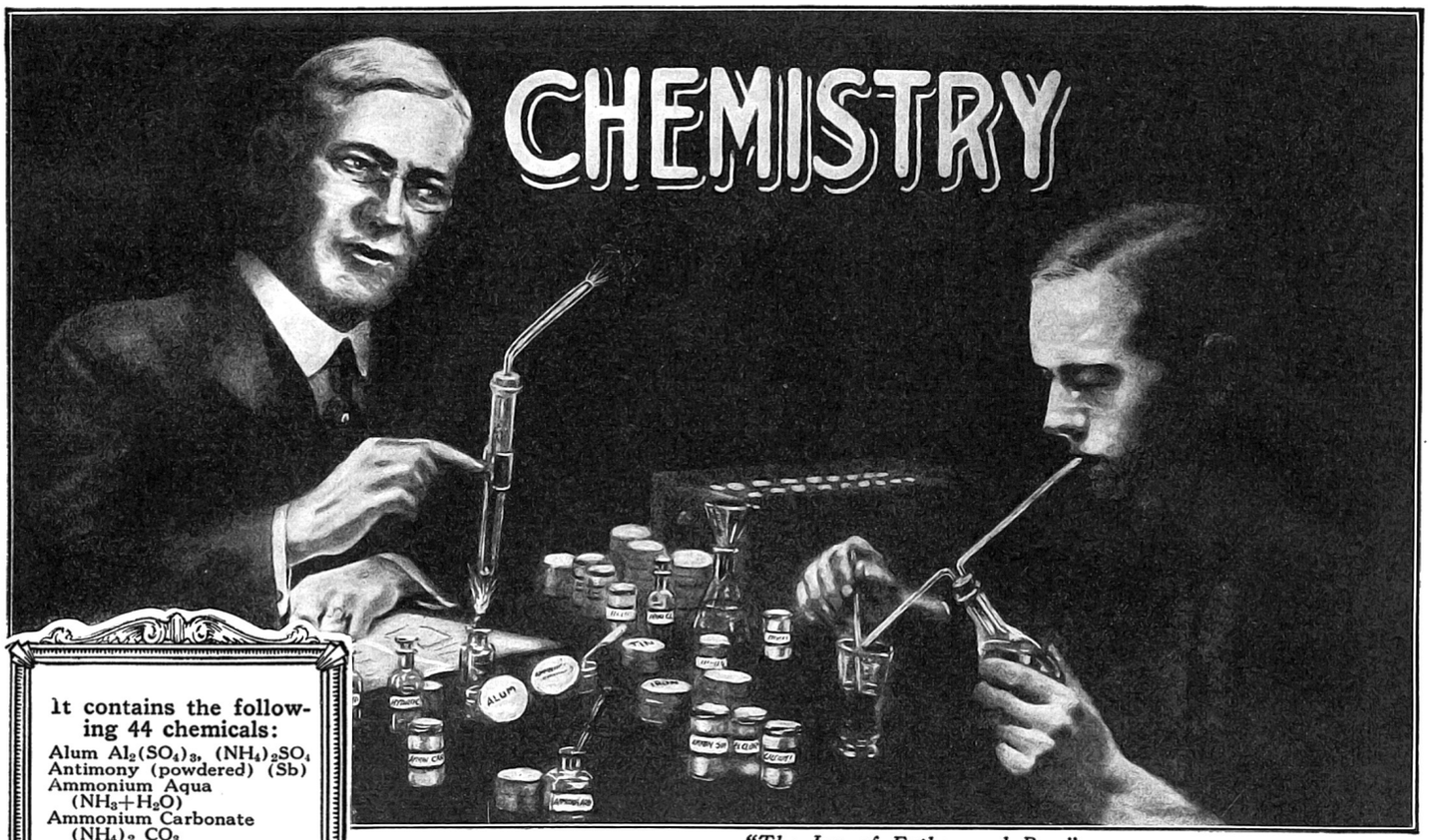

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Copper Sulphate ($CuSO_4$)
Ferrous Sulphate ($FeSO_4$)
Ferrous Sulphide (FeS)
Glycerol (Glycerine) $C_3H_5(OH)_3$
Hydrochloric Acid (HCl)
Iodine (I)
Iron Chloride ($FeCl_2$)
Iron Oxide (Fe_2O_3)
Lead Acetate Pb $(C_2H_3O_2)_2$
Litmus Paper
Magnesium Carbonate ($MgCO_3$)
Manganese Dioxide (MnO_2)
Mercury (Quicksilver) (Hg)
Nickel Chloride ($NiCl_2$)
Oxalic Acid ($H_2C_2O_4$)
Sodium Bicarbonate ($NaHCO_3$)
Sodium Borate ($NaBO_2$)
Sodium Carbonate (Na_2CO_3)
Sodium Chloride (NaCl)
Sodium Nitrate ($NaNO_3$)
Sodium Phosphate (Na_2HPO_4)
Sodium Sulphate (Na_2SO_4)
Sodium Sulphite (Na_2SO_3)
Stannous Chloride ($SnCl_2$)
Sulphate of Nickel ($NiSO_4$)
Sulphate of Zinc ($ZnSO_4$)
Sulphuric Acid (H_2SO_4)
Tin (Granulated) (Sn)
Zinc (Metal) (Zn)
Zinc Carbonate ($ZnCO_3$)

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A good part of the book is devoted to Weights and Measures. The Metric System, the English system and the U. S. System are fully explained.

The following tables are furnished: Symbols and Atomic weights of the Elements; Measures of Weights, Volume, Capacity and Length; Per Cent solutions; Conversion of Measure expressed in parts; Poisons and their antidotes; Technical and common name of chemical substances; Formulas for Cleaning various substances, etc., etc.

Among the **100 Experiments** are:

How to make chemical tricks; How to make invisible and magic inks; How to test flour; How to test soil; How to Make Chlorine Gas and smoke (German War Gas); How to bleach cloth and flowers. How to produce Oxygen and Hydrogen; How to make chemical colors; How to test Acids and Alkalies and hundreds of interesting hints and formulas.

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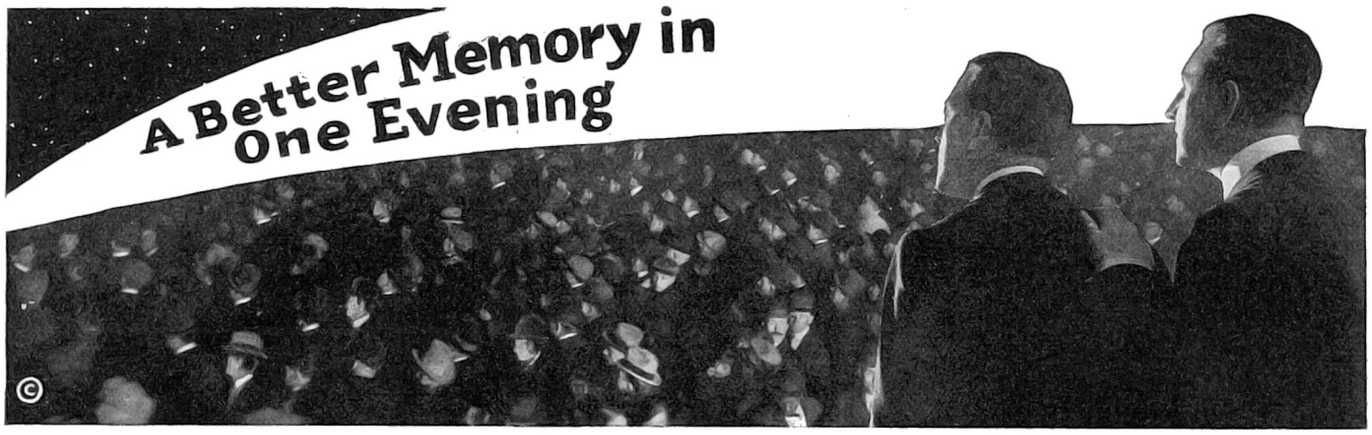

Can You Be Given A Better Memory In One Evening?

It has been done for over a quarter of million men and women in all walks of life—what they say about their amazing experiences

A BETTER memory in one evening It sounds impossible. Yet this is exactly what Mr. Roth, the world-famous memory expert, has done for over a quarter of a million men and women—given them a better memory in a single evening!

You've doubtless seen Mr. Roth give his startling memory demonstrations in public. At any rate, you've heard of him.

No one denies that Mr. Roth himself has a remarkable memory—that has been proved beyond question. But many people say that while Mr. Roth's marvelous memory is beyond dispute, it was "born in him," and that it is doubtful if the average man or woman can ever develop a memory that approaches Mr. Roth's. And, least of all, in one evening! A fair question, that. So let us see how it works out in actual practice.

From time to time testimonials have been published from enthusiastic users stating the wonderful memory powers they have developed by following Mr. Roth's method. Evidence from people who have actually done it is conclusive. And, in addition to this, the publishers of Mr. Roth's Memory Course have offered to send it on five days' free trial. No money was asked for. The entire course was sent wholly on approval. The recipient was free to test Mr. Roth's method for five days. Then if he found that it had not brought about a remarkable improvement in his memory, he could return the Course and he wouldn't be out a penny. An offer such as this could not have been made unless the Course would do all that was claimed for it.

Over a quarter of a million Roth Memory Courses have been sent out to the general public—and paid for—on this basis. What happened? This—the publishers were flooded with letters endorsing the Roth Memory Course in the highest possible terms. By far the great majority of people paid for the Course in less than five days. So delighted were they with the remarkable improvement it had made in their memory, that they were eager to own it at once.

If you could drop into the offices of the publishers you would be shown a huge pile of enthusiastic testimonial letters which would take you days to read. They all tell the same story—amazement at the wonderful nature of the Course—enthusiasm over the marked improvement it has made in weak memories—appreciation of the opportunity to possess it—and surprise at the low cost!

These thousands upon thousands of letters of appreciation came from Members of Congress, ministers, doctors, lawyers, professors, teachers, students, managers, clerks, stenographers, bookkeepers, salesmen, factory executives—men and women in all walks of life.

What they say:

"Every business man should avail himself of this wonderful system of Memory Training."
G. L. Helms, Indianapolis, Ind.

"I have studied only the first lesson, but it has proved invaluable."
R. H. Gifford, Chicago.

"Worth thousands of dollars to anyone in business."
J. M. Thompson, Columbus, O.

"It has been of such great value to me as a lawyer that I cannot find words to express my appreciation."
George J. Lemmon, Denver, Col.

"So simple and fascinating that it is play to study it."
E. W. Buckingham, M.D., Norfolk, Va.

"I am amazed at my increased memory powers since studying the first lesson."
Anne S. Leach, Wytheville, Va.

"I am thankful to have your Course. It is worth many times five dollars."
Rev. J. A. Northrup, Streator, Ill.

"The system works like magic."
Ralph D. Stoddard, Cleveland, O.

"I was surprised to see how I improved my memory the first evening."
M. J. Blackenshop, Mohawk, W. Va.

"I find that I can do my work much easier after studying the first two lessons."
A. R. Johnson, Palestine, Texas.

"It has done wonders for me."
Arthur Lippincott, Erie, Pa.

"Wonderful!—I would not sell it for any amount of money."
Ella Busse, State College, Pa.

Here are extracts from a few of the many thousands of letters received from users of the Roth Memory Course:

"You claim to give 'a better memory in one evening.' You ought to change it to 'one hour,' for I improved my memory 100 per cent in one hour."

Many a man who is called upon to speak in public fails to get his message "across" because a weak memory forces him to read from notes. A prominent public man says:

"I have made a wonderful improvement in my ability to speak in public. Formerly I had to read from notes. Now I can speak extemporaneously and get a smash and drive in my talk which amazes me as much as it impresses my audience."

Lots of people who can think keen thoughts fail miserably when it comes to talking them. They blame their lack of confidence and a limited vocabulary. In most cases the real cause is a weak memory. An enthusiast writes:

"No longer do I stammer, and sputter my words. Now I am looked upon as a brilliant conversationalist, and the Roth Memory Course did it."

Many a business man is handicapped because he cannot instantly recall prices, selling talks, and other data about his business. A salesman says:

"I had been trying to memorize a selling talk for several weeks, but failed completely. By applying Mr. Roth's principles I memorized it in thirty minutes."

The main handicap of the young man in business is lack of experience. Experience is largely a matter of never forgetting facts and experiences which apply to the matter under consideration. A young man says:

"I have just been promoted to an important position which I never dreamed of getting for at least five years. The Roth Memory Course got me the promotion by enabling me to instantly recall all the vital facts and figures about our business which I have ever learned."

Educators by the score write in to say that the Roth Memory Course should be taught in every school and college, and that it would not only make better students, but would considerably shorten the period of instruction.

The father of a little girl of 13 says: "As a result of using Mr. Roth's principles my little girl's papers are rated the highest in the class."

Students by the dozen say that the Roth Memory Course enables them to master in a few hours studies that formerly required weeks of grinding effort.

One of the greatest surprises about the Roth Memory Course is that there is really nothing to study and no hard work to do. It is largely a question of following a few simple principles. In one hour you can improve your memory—in an evening you can easily double its power—and inside of a week you can have a memory that will surprise you as well as your friends.

"I am amazed at the simplicity of this wonderful work"—"studying it is a continuous pleasure"—"The system works like magic"—"I am thrilled by the power the Course gives me"—"It is as simple as child's play and as efficient as a filing cabinet"—expressions like these have been written in by the score.

And the price!—

"The first lesson alone is worth 100 times $5," says one enthusiast. Hundreds of people have stated that they would gladly have paid many times the price of five dollars. "I am sending you the money by return mail,"—and "I've never let go of a 'five' with so much pleasure," says another.

You have always wanted a "good memory." Now you can have it. There is no laborious study to undertake. Mr. Roth shows you that a good memory depends mainly on applying a few simple principles which you can learn in less than thirty minutes. You can master the whole Course in a few hours of delightful reading.

Here is what you will find after you apply Mr. Roth's simple principles: Names and faces will flash instantly to your mind. Facts and figures which you now forget, or laboriously write down, will be on the tip of your tongue the instant you want them. Your conversational powers will improve wonderfully. The right word, the right expression, the right thought will almost speak itself the instant you want it. Never again will you be humiliated by saying, "I forgot!" Once put a thing into your mind and it will be there as permanently as though etched in steel, and as easily recalled as taking a card out of a card-index. Your mental powers will become sharper and quicker. At all times you will have that keenness of mind most men experience only occasionally. Your self-confidence will increase. You will thrill with a new sense of power. You will—

But there's no need to go further. For you can see for yourself, at no cost, exactly what the Roth Memory Course will do for you. Merely fill in and mail the coupon. Send no money. The complete Course will be sent to you immediately, all charges prepaid. Examine it thoroughly. Test it in every way you can think of. Apply its simple principles. Note the almost magical change it brings about in your memory.

Then, after you have done this, if you feel that you can possibly afford to be without the Roth Memory Course, send it back and you will owe nothing. But if you feel, as over a quarter of a million others have felt, that you simply cannot afford to be without the Roth Memory Course, then send only five dollars in full payment.

In one week from today you can have a memory that will thrill you with power and amaze your friends. You can do this if you mail the coupon NOW.

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$100.00 RADIO CONTEST is announced in the July issue of RADIO AMATEUR NEWS.

"An Ideal Receiving Outfit" is the subject of the contest. $100.00 in cash prizes for the best manuscripts submitted.

JUDGES OF THE CONTEST ARE:

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Dr. Greenleaf W. Pickard, Inventor of the Crystal Detector
Dr. Louis Cohen, Ph.D., Radio expert and inventor
Samuel D. Cohen, Amateur Radio expert
H. W. Secor, Assoc. I.R.E., Associate Editor, Electrical Experimenter
H. Gernsback, Editor, Electrical Experimenter & Radio Amateur News
Fritz Lowenstein, Radio expert

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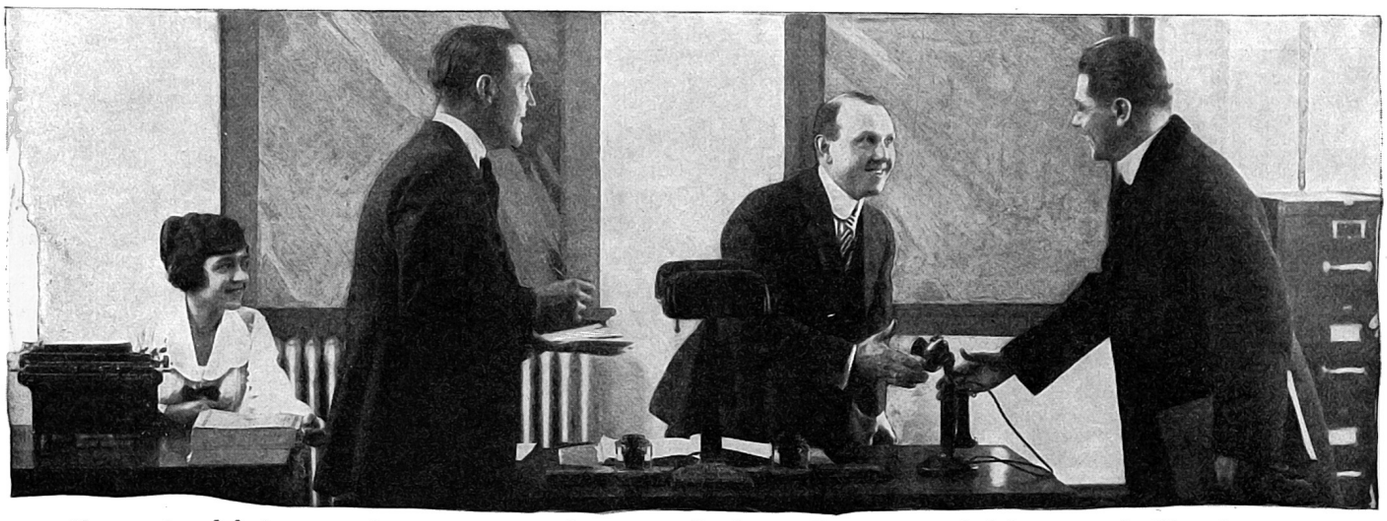

"I was astounded at my new power over men and women. People actually went out of their way to do things for me—they seemed EAGER TO PLEASE ME"

The Secret of Making People Like You

"Getting people to like you is the quick road to success—it's more important than ability," says this man. It surely did wonders for him. How he does it—a simple method which anyone can use instantly

ALL the office was talking about it and we were wondering which one of us would be the lucky man.

There was an important job to be filled—as Assistant-to-the-President. According to the general run of salaries in the office, this one would easily pay from $7,000 to $10,000 a year.

The main requisite, as we understood it, was striking personality and the ability to meet even the biggest men in their offices, their clubs and their homes on a basis of absolute equality. This the firm considered of even more importance than knowledge of the business.

YOU know just what happens when news of this sort gets around an office. The boys got to picking the man among themselves. They had the choice all narrowed down to two men—Harrison and myself. That was the way I felt about it, too. Harrison was big enough for the job, and could undoubtedly make a success of it. But, personally, I felt that I had the edge on him in lots of ways. And I was sure that the firm knew it too.

Never shall I forget my thrill of pleasure when the president's secretary came into my office with a cheery smile, looked at me meaningly, handed me a bulletin, and said, "Mr. Frazer, here is the news about the new Assistant-to-the-President." There seemed to be a new note of added respect in her attitude toward me. I smiled my appreciation as she left my desk.

At last I had come into my own! Never did the sun shine so brightly as on that morning, and never did it seem so good to be alive! These were my thoughts as I gazed out of the window, seeing not the hurrying throngs, but vivid pictures of my new position flashing before me. And then for a further joyous thrill I read the bulletin. It said, "Effective January 1, Mr. Henry J. Peters, of our Cleveland office, will assume the duties of Assistant-to-the-President at the home office."

PETERS! Peters!—surely it *couldn't* be Peters! Why, this fellow Peters was only a branch-office salesman. . . . *Personality!* Why, he was only five feet four inches high, and had no more personality than a mouse. Stack him up against a big man and he'd look and act like an office boy. I knew Peters well and there was nothing to him, nothing at all.

January the first came and Peters assumed his new duties. All the boys were openly hostile to him. Naturally, I felt very keenly about it, and didn't exactly go out of my way to make things pleasant for him—not exactly!

But our open opposition didn't seem to bother Peters. He went right on with his work and began to make good. Soon I noticed that, despite my feeling against him, I was secretly beginning to admire him. He was winning over the other boys, too. It wasn't long before we all buried our little hatchets and palled up with Peters.

The funny thing about it was the big hit he made with the people we did business with. I never saw anything like it. They would come in and write in and telephone in to the firm and praise Peters to the skies. They insisted on doing business with him, and gave him orders of a size that made us dizzy to look at. And offers of positions!—why, Peters had almost as many fancy-figure positions offered to him as a dictionary has words.

WHAT I could not get into my mind was how a little, unassuming, ordinary-to-look-at chap like Peters could make such an impression with every one—especially with influential men. He seemed to have an uncanny influence over people. The masterly Peters of today was an altogether different man from the commonplace Peters I had first met years ago. I could not figure it out, nor could the other boys.

One day at luncheon I came right out and asked Peters how he did it. I half expected him to evade. But he didn't. He let me in on the secret. He said he was not afraid to do it because there was always plenty of room at the top.

What Peters told me acted on my mind in exactly the same way as when you stand on a hill and look through binocular glasses at objects in the far distance. Many things I could not see before suddenly leaped into my mind with startling clearness. A new sense of power surged through me. And I felt the urge to put it into action.

Within a month I was getting remarkable results. *I had suddenly become popular.* Business men of importance who had formerly given me only a passing nod of acquaintance suddenly showed a desire for my friendship. I was invited into the most select social circles. People—even strangers—actually went out of their way to do things for me. At first I was astounded at my new power over men and women. Not only could I get them to do what I wanted them to do, but they actually anticipated my wishes and seemed eager to *please me.*

One of our biggest customers had a grievance against the firm. He held off payment of a big bill and switched to one of our competitors. I was sent to see him. He met me like a cornered tiger. A few words and I calmed him. Inside of fifteen minutes he was showering me with apologies. He gave me a check in full payment, another big order, and promised to continue giving us all his business.

I could tell you dozens of similar instances, but they all tell the same story—the ability to make people like you, believe what you want them to believe, and to do what you want them to do. I take no personal credit for what I have done. All the credit I give to the method Peters told me about. We have told it to lots of our friends, and it has enabled them to do just as remarkable things as Peters and I have done.

BUT YOU want to know what method I used to do all these remarkable things. It is this: You know that everyone doesn't think alike. What one likes another dislikes. What pleases one offends another. And what offends one pleases another. Well, there is your cue. You can make an instant hit with anyone if you say the things they want you to say, and act the way they want you to act. Do this and they will surely like you, and believe in you, and will go out of their way to PLEASE YOU.

You can do this easily by knowing certain simple signs. Written on every man, woman and child are signs, as clearly and as distinctly as though they were in letters a foot high, which show you from one quick glance exactly what to say and to do to please them—to get them to believe what you want them to believe—to think as you think—to do exactly what you want them to do.

Knowing these simple signs is the whole secret of getting what you want out of life—of making friends, of business and social advancement. Every great leader uses this method. That is why he is a leader. Use it yourself and you will quickly become a leader—nothing can stop you. And you will want to use it if for no other reason than to protect yourself against others.

WHAT Peters told me at luncheon that day was this: "Get Dr. Blackford's 'Reading Character at Sight.'" I did so. This is how I learned to do all the remarkable things I have told you about.

You have heard of Dr. Blackford, the Master Character analyst. Many concerns will not employ a man without first getting Dr. Blackford to pass on him. Concerns such as Westinghouse Electric and Manufacturing Company, Baker Vawter Company, Scott Paper Company and many others pay Dr. Blackford large annual fees for advice on dealing with human nature.

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Remember, you take no risk, you assume no obligation. The entire course goes to you on approval. You've everything to gain—nothing to lose. So mail the coupon NOW, while this remarkable offer remains open.

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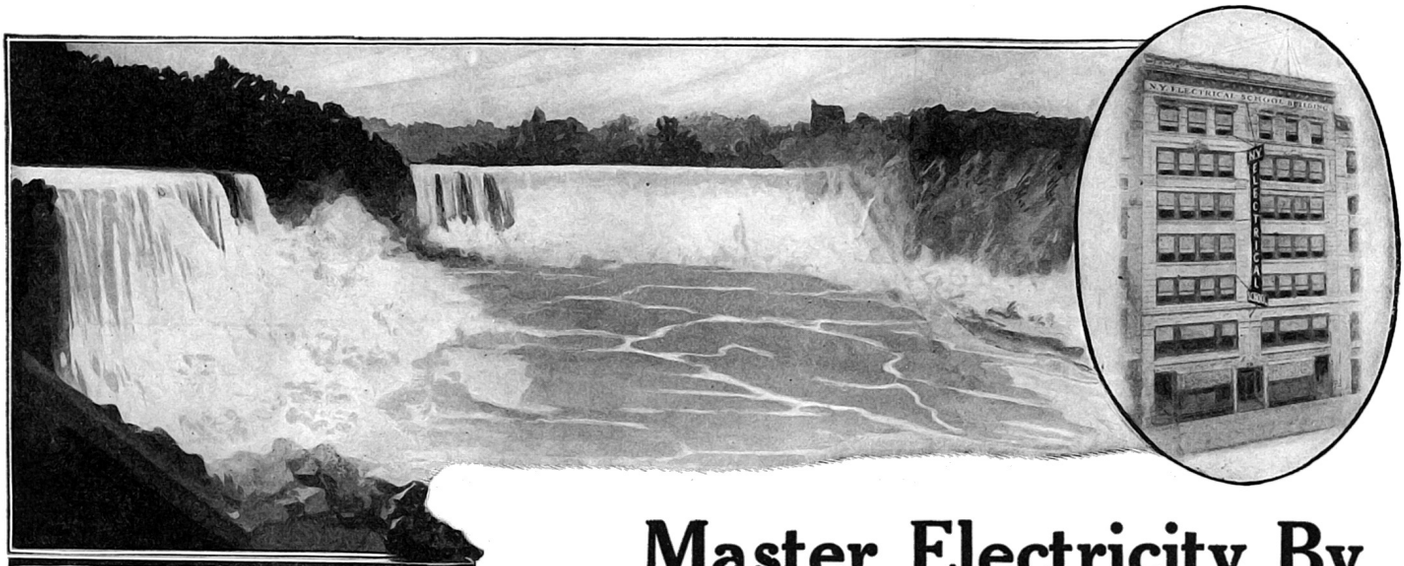

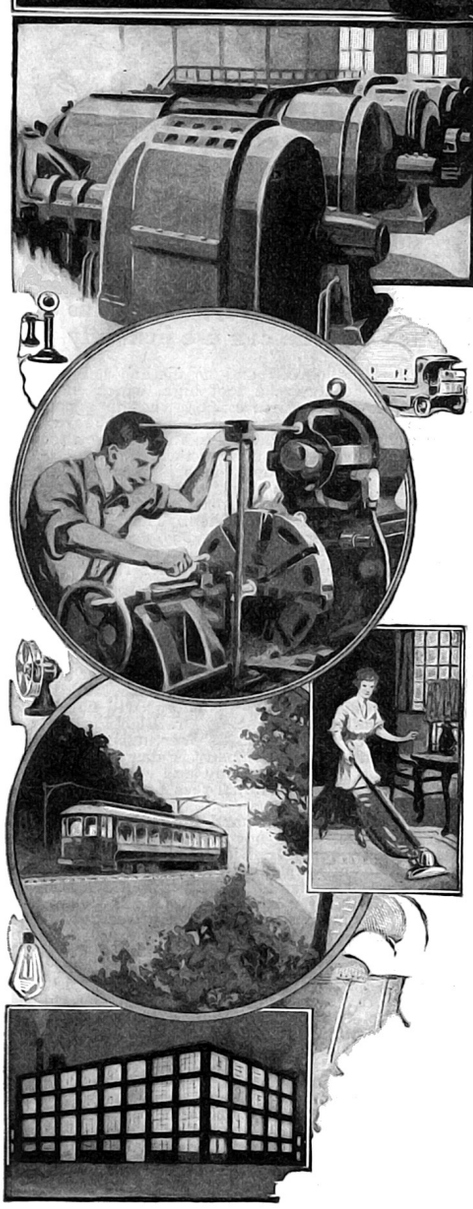

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Vol. VII: Whole No. 75 JULY, 1919 No. 3

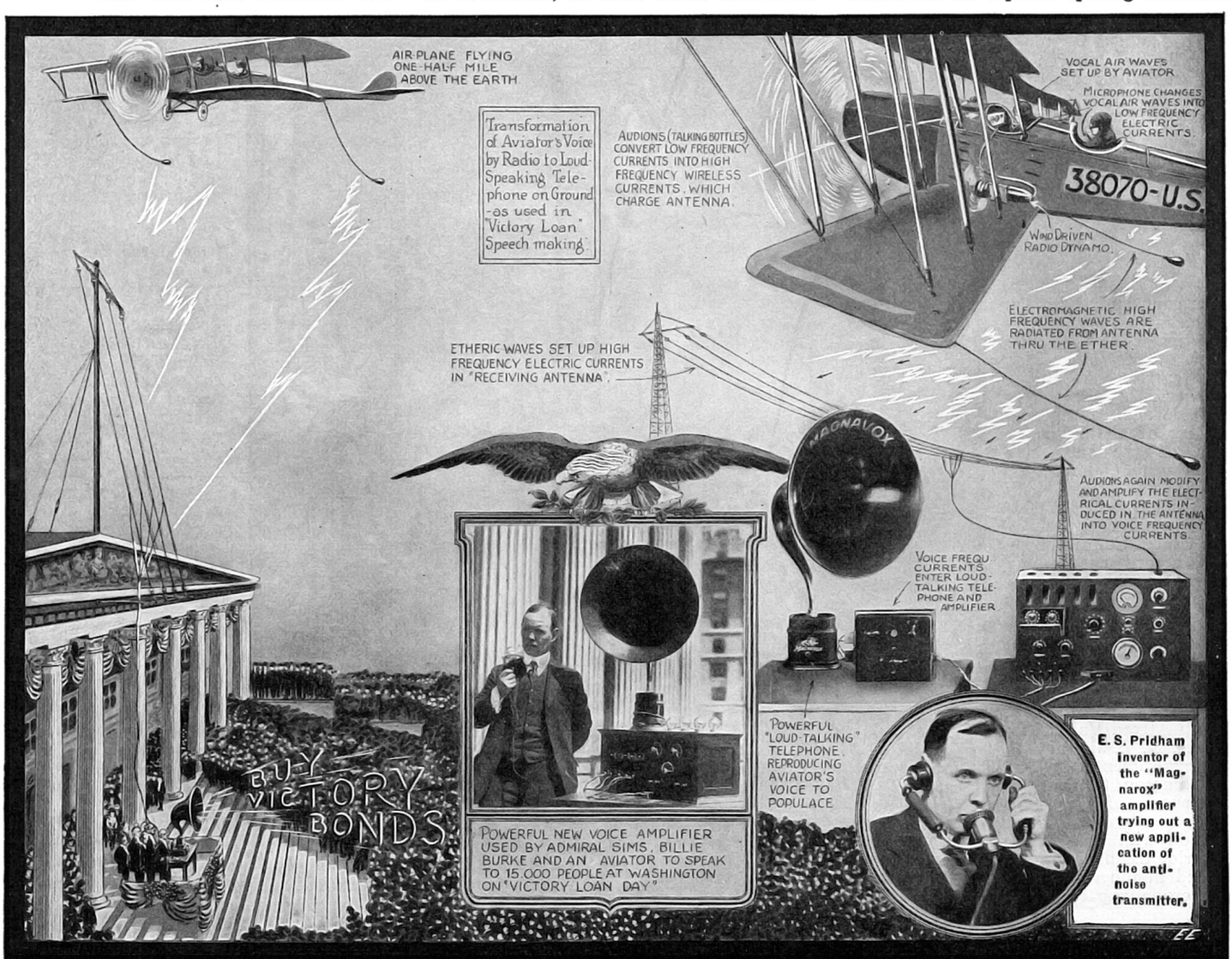
Talking from 'Plane to Earth

How it is Done Explained in Non-Technical Terms

"HELLO! hello, Treasury!" cried the aviator. "I am now 2,600 feet over you in plane 38,070 from Bolling Field." The aviation officer then read President Wilson's "Victory Liberty Loan" message by wireless, thru the air, and concluded by bidding good-bye to the crowd. Lieutenant H. E. Metcalf, the radio officer aboard the 'plane, talked from an airplane flying 2,600 feet overhead to 15,000 persons assembled at the southern steps of the Treasury, at Washington, D. C., by the use of the wireless telephone and a newly invented *sound amplifier,* which possesses great power.

The throng of Government employes, dismissed for the capital's opening demonstration for the loan, cheered the President's message as spoken thru the air and enun-

(*Continued on page* 281)



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Thanks to the Remarkable Developing of the "Loudspeaking" Wireless Telephone in His Absence, President Wilson Will Be Able to Talk to His Constituents on This Side of the Atlantic from Midocean on His Way Home. It is estimated that the President's Voice May Be Heard by 50,000 Persons Grouped About a Reproducer Here, While He Is Yet 1,000 Miles at Sea. The New Wireless Telephone Device Is the Invention of Three San Francisco Men—E. S. Pridham (Shown in the Picture), P. L. Jensen and O. B. Moorehead. It Consists of an Anti-Noise Transmitter, Called a "Magnavox," and an Amplifier. It was Used by Admiral Sims and Billie Burke When They Addrest 15,000 People on the Steps of the United States Treasury Building, Washington, D. C. Mr. Pridham, on "Victory Loan Day," April 21, Personally Supervised the Demonstration of the Wonderful New Anti-Noise Telephone That Made Telephone History. An Aviator 2,600 Feet (One-Half Mile) Overhead Spoke, With This Instrument, to 15,000 People Thru a "Magnavox" Amplifier.

Talking Thru the Trees

By MAJOR-GENERAL GEORGE O. SQUIER

Chief Signal Officer, U. S. Army

How Trans-Atlantic Radio Messages Are Copied Via Tree Antenna

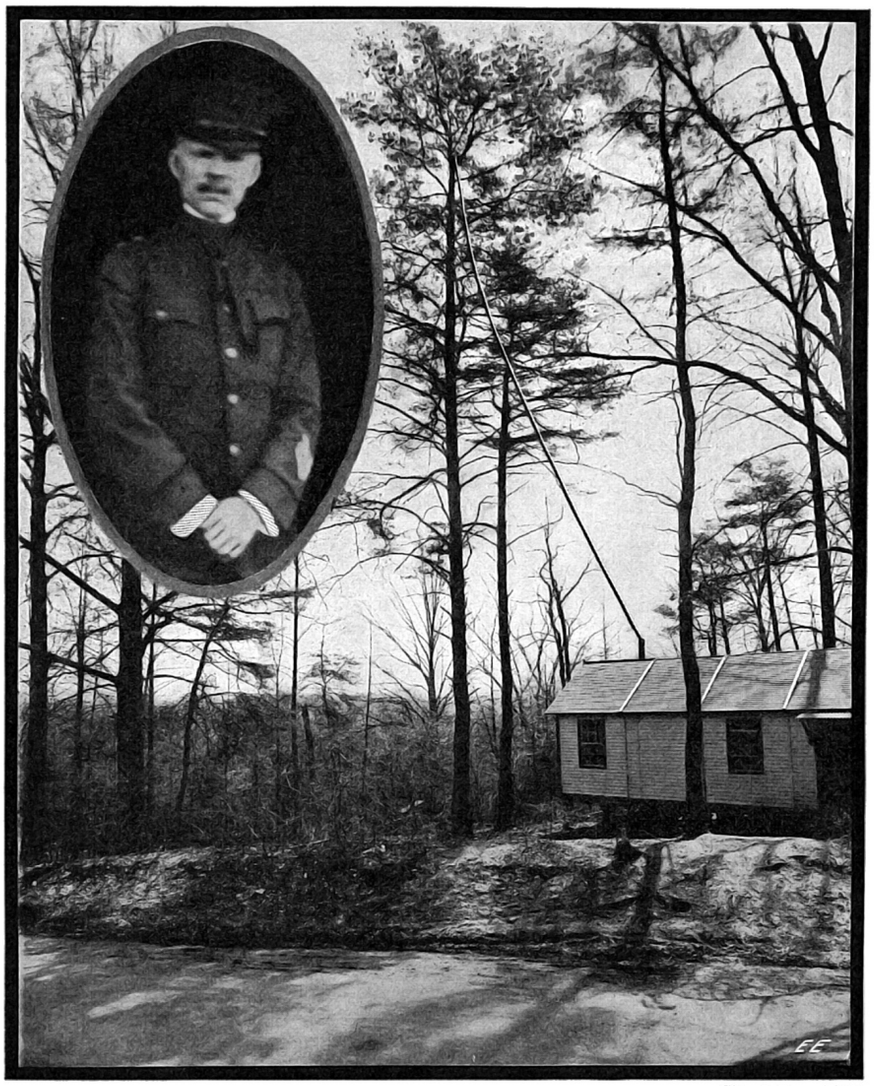
European Radio Signals, Via the Trees.

AS long ago as 1904, the author conducted some experiments with a view to utilizing growing trees as *antennae* for radio-telegraphy and discovered the efficacy, in a general way, of using a direct metallic contact to certain trees (principally *eucalyptus*) to increase the audibility of radio signals. My attention was first called to this phenomenon during the course of summer maneuvers of the Army at Camp Atascadero, Calif., where, due to the prevalence of the dry season and the unusual character of the soil, it was found that the regular Army buzzer telephone and telegraph sets were inoperative with any ordinary ground or earth but became operative when connected to a metallic nail driven in the trunk or roots of a *live tree*. This incident led the author to pursue the subject experimentally in the autumn of 1904 continuing the experiments to the range of frequencies then employed in radio-telegraphy.

Tree Antennae.

In connection with the organization and development of *Transatlantic radio reception*, which was carried out during the period of the war to provide against the possibility of the interruption of the submarine cable system, the Signal Corps established a chain of special receiving stations in different parts of the United States to copy and record enemy and Allied radio messages from European stations for the information of our Army General Staff.

In the prosecution of this work, directions were given to the Signal Corps Laboratory at Camp Alfred Vail, Little Silver, N. J., and also to the experimental staff in Washington to test the efficiency of *growing trees* as receiving antennae, in connection with this service, using the vastly superior technique and facilities now represented in the radio Art as compared with the crude apparatus with which the discovery was made in 1904. With a collection of apparatus representing the most advanced state of the radio Art, the problem, as a war measure, was attacked anew and has now reached a point where a very brief outline of some of the physical results obtained should be presented in the interests of the development of the Art in general. Since the phenomena involved embrace a variety of physical problems rather than strictly engineering ones, these data are presented in the hope that our scientists may see in the experiments some points of departure for further research.



Signal Corps Photo

The U. S. Signal Corps Laboratory Near Washington, D. C., Where Remarkable Results Were Obtained Using Living Trees as Radio Antennae. Signals from Europe and Other Countries Were Easily Copied. Trees Have Been Successfully Used Also for Radiophone Transmission. Insert View: Major General George O. Squier, Inventor of "Tree Wireless."

It was immediately discovered that with the sensitive amplifiers now in use it was possible to *receive signals from the principal European stations* by simply laying a small wire netting on the ground beneath the tree and connecting an insulated wire *to a nail driven in the tree well within the outline of the tree top.* See Fig. 1. Messages having been received from England, France, Germany and Italy.

This encouraging first result justified a more careful examination of the phenomena and the most suitable arrangement of circuits for the purpose.

And Now the "Floraphone."

The messages carried over this tree telephone and telegram system have been named by the writer. They are to be "floragrams." The tree telephone is to be a "floraphone"; the tree telegraph a "floragraph."

The discovery is now announced after experiments covering fifteen years, beginning in California and continuing intermittently until the outbreak of the war, when they went forward with vigor as an emergency means of communication. The system was utilized during the war in "listening in" on the German radio communication.

The final development took place in a small portable laboratory, purchased from a mail order house, capable of being carried to any place in the woods. A group of soldiers, sleeping in the house and taking turns at copying messages, assisted the writer in the development of the apparatus.

Without entering into the details of these preliminary experiments here it may be said that one of the best receiving arrangements is found to be an elevated tree earth-terminal in the upper part of the tree top, *and an earth consisting practically of several short pieces of INSULATED wire, SEALED AT THE OUTER END, radiating out from a common center, and buried a few inches beneath the surface of the ground in the neighborhood of the tree.* See Fig. 2.

It was soon found that a tree-antenna could be used efficiently as a *multiple radio receiving set over widely different wave lengths,* see Fig. 3A, receiving either from separate terminals at the same (shown dotted in Fig. 3A) or different heights of the tree, *or in series from the same terminal.* See Fig. 3B.

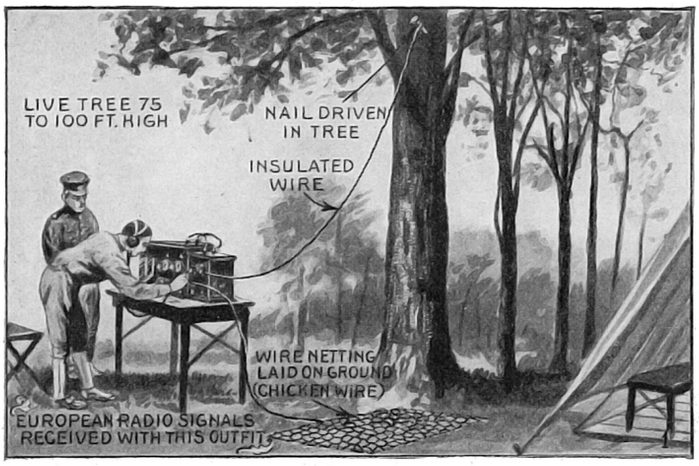
This same type of circuit was employed in an inverse manner for radio-telephonic transmitting purposes, altho the experiments thus far have been limited to short distances. It was found that 2-*way radio telephonic communication* was easily established with remarkably low values of transmitting antenna current. See diagram of this test illustrated at Fig. 4.

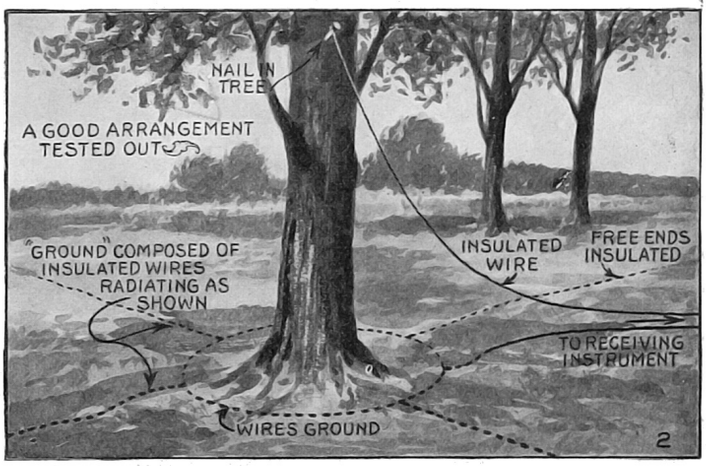
The flexibility of this arrangement is very striking. The linking up of *wire* and *wireless* methods was found to be both convenient and efficient. *Radio-telephonic messages from airplanes* were readily received by the tree-antenna arrangement and *transferred thence to the wire system* of the city of Washington and finally received at any point desired. See Fig. 5.

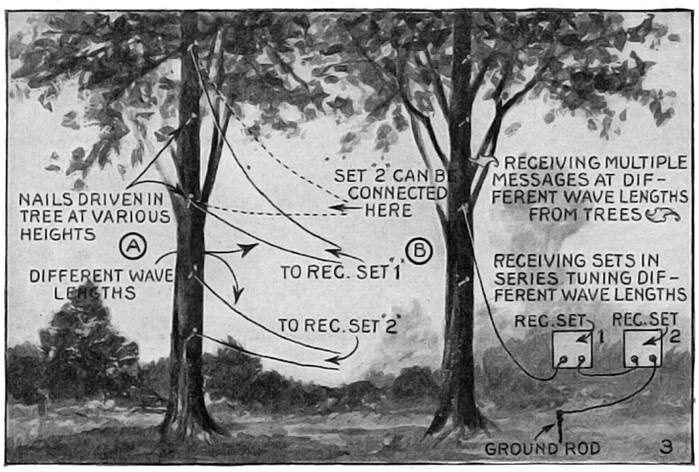
Furthermore, *radio-telephonic transmission* thru the tree-antenna was *received by*

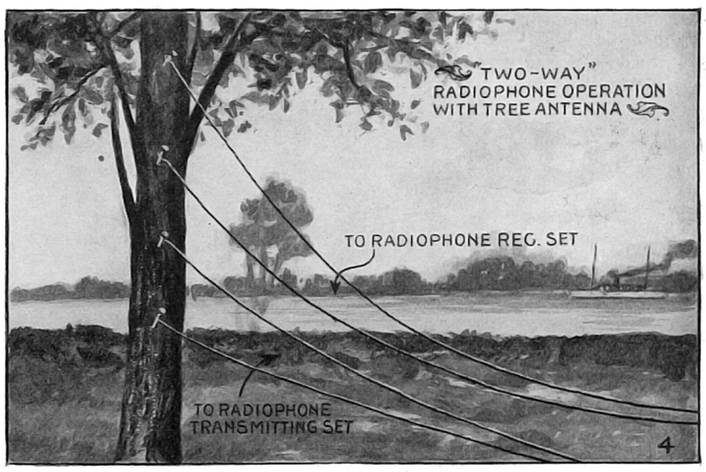
(*Continued on page* 271)

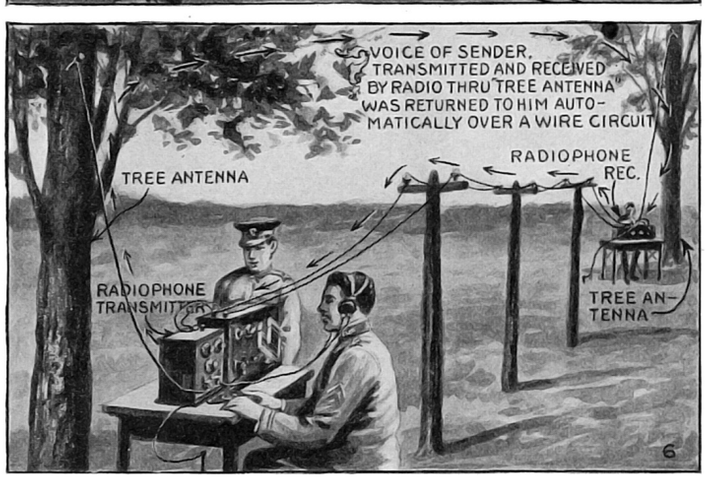
TREE WIRELESS

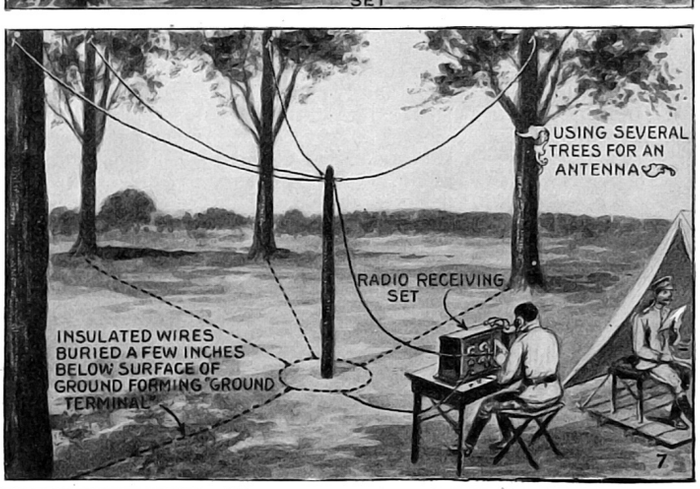


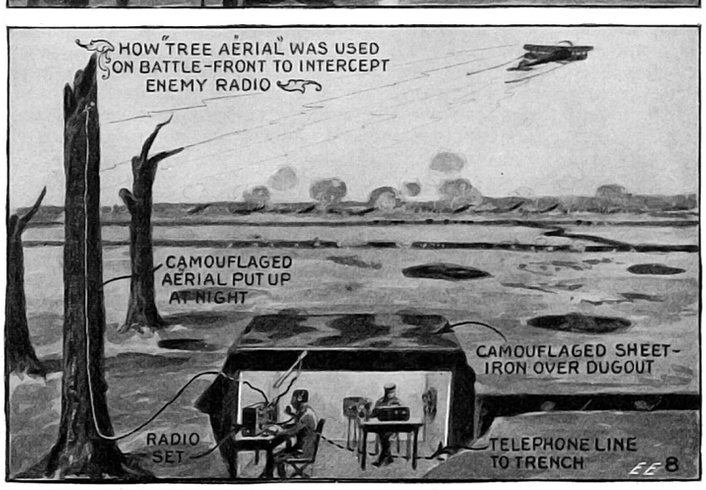












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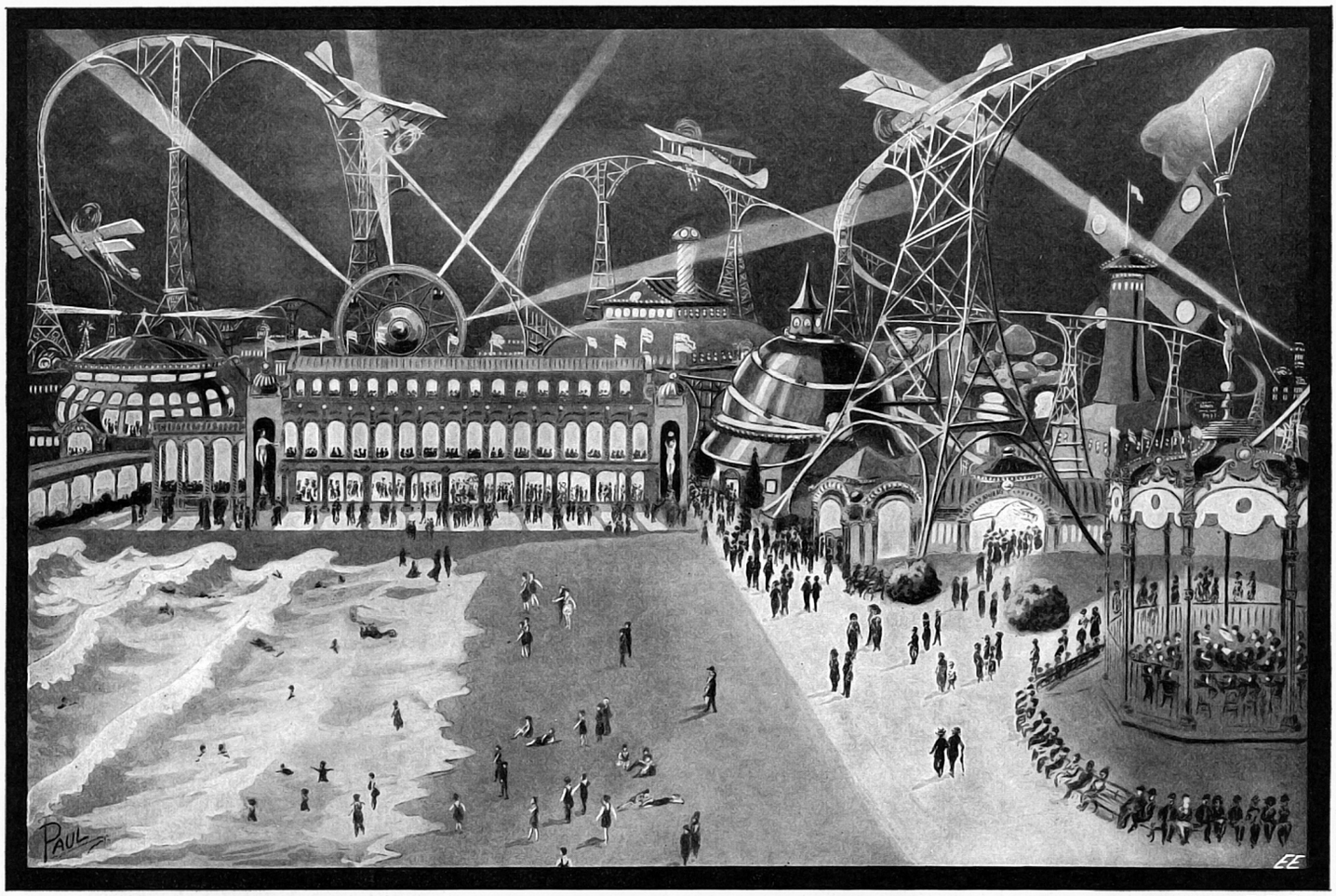
FULL DESCRIPTION OF TREE AËRIALS ON OPPOSITE PAGE.



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Dashing Thru the Night With Flames Spouting from Their Exhaust Pipes, and Propellers Whirling, Shoot These Captive Airplanes With Their Joy-Seeking Passengers. The Latest Idea in the Summer's Pleasure Grounds. The "Bronx Exposition Amusement Park," in New York City, Will Feature This Diversion. It Gives All the Thrills of a Real Ride in an Airplane.

A Dash to the Clouds

By GEORGE HOLMES

THE restless feeling that comes to everyone at the first sign of spring—the trees budding, birds returning from the South and gaily announcing the rise of the sun each morn—stirs the blood of every man, woman and child, the young or old, and makes them want to get out into the great outdoors. Those who are not able to go far away into the hills, mountains and seashore for extended periods to cure this "spring fever" must needs find some attraction nearer home. The average person dwelling in the city in the little cigar boxes we are wont to call apartments finds himself cramped for room. It is like the old story of the dog who was forced to wag his tail up and down, instead of sideways. He *had* to wag it up and down because the walls of the apartment were too close together and he could not wag it any other way.

Enterprising business men have found a solution for the everyday worker and his family, by bringing within easy reach amusement parks and seaside resorts, where he may either spend a week with his family or have his family there during the week and be able to go there himself in the evenings after he is thru with the business of the day, and also on Saturdays and Sundays. Principal among these resorts, one rather new and practically in its infancy, but rapidly growing, is the *Bronx Exposition Amusement Park,* within the boundary of New York City.

Just a short time ago, in visiting the grounds, you could hear the hammering and sawing of carpenters, the concrete mixers running, steel and structural workers on the job, and general signs of activity. To the layman this work has always proven of great interest, but so few have the opportunity of witnessing these gigantic buildings rise as if from nothing. Usually under cover in great secrecy, these surprises are manufactured. On the opening day, the great crowds of visitors come to gasp in astonishment at the amazing array of amusement devices, both old and new, devised and evolved during the long winter slumber between seasons.

This year we have what is perhaps the largest, greatest and most spectacular device ever before shown to the public. In the many years of fairs, expositions and amusement parks, gone by, we have never before witnest a most startling affair than that of the *"Captive Airplane"* complete in every detail, spouting flames from its exhausts, and the whirring of the propeller, mounting higher and higher into the heavens, and then shutting off its power, in a series of dips taking away one's breath, gradually coming back to the starting point. This device, which has never been tried out before, even in the model form, is being constructed from plans evolved as the work progresses, and has every possibility of becoming a success. There will be several machines which will consist of the regular airplane body, wings and necessary stays. In addition there will be a motor attached to the propeller. This motor and propeller will be more for attraction and sensation than actual driving power. The cars themselves will travel on a monorail track driven by electric power taken thru a contact shoe to the rail and back to the motors underneath the car. This machine will start from a height of about 5 feet above the ground and gradually rises over a steep incline several hundred feet over the tops of the amusement buildings, and, arrived at the top, the power will be shut off, when the car will begin its dizzy descent of the many loops of monorail track. Death defying, some people might say, but so scientifically and carefully is this device constructed that there is not the least bit of danger to any of the sixteen passengers in the car. Most glorious will be the spectacle at night when the many lights of the park and searchlights will play upon the snorting monster of the air as it carries its load of pleasure-seekers on its startling trip thru the clouds, for then it will present the true airplane appearance, as no track will be visible. It will give an effect far greater than can ever be shown in our illustration.

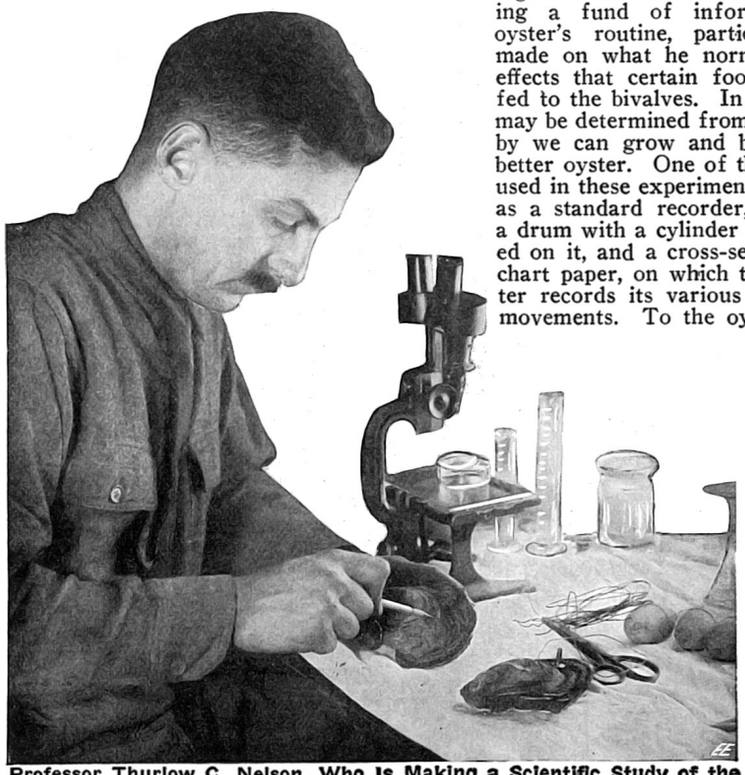
Approximately 175,000 feet of lumber will go into the making of this new airplane railway. The railway itself from start to finish will be 3,200 feet in length, each car carrying sixteen persons. The

(*Continued on page* 244)

The Oyster's Autograph

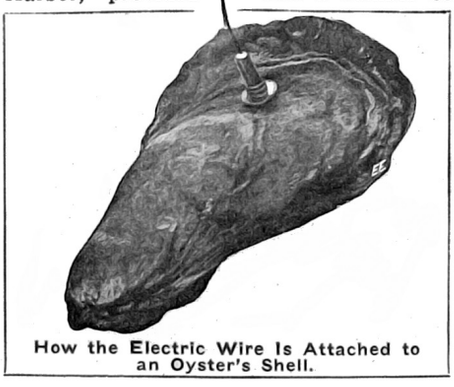
How the Oyster tells us when he eats

IF we could learn what food the oyster really needs, we could then raise better crops of this highly delicious and edible sea food. Not being possest of any supernatural powers, we must resort to some crude means, mechanical or electrical, for determining the environment factors and the foods which are best suited to the oyster. This field up to a short time ago had not been investigated to any appreciable extent. Heretofore, the growth of the oyster had been left mostly to fishermen, who, in raising these oysters in the oyster beds, had not been doing all that was best for them, causing illness and even deaths in many instances by poisoning in one form or another thru eating oysters which had possibly reposed in sewage or other polluted waters.



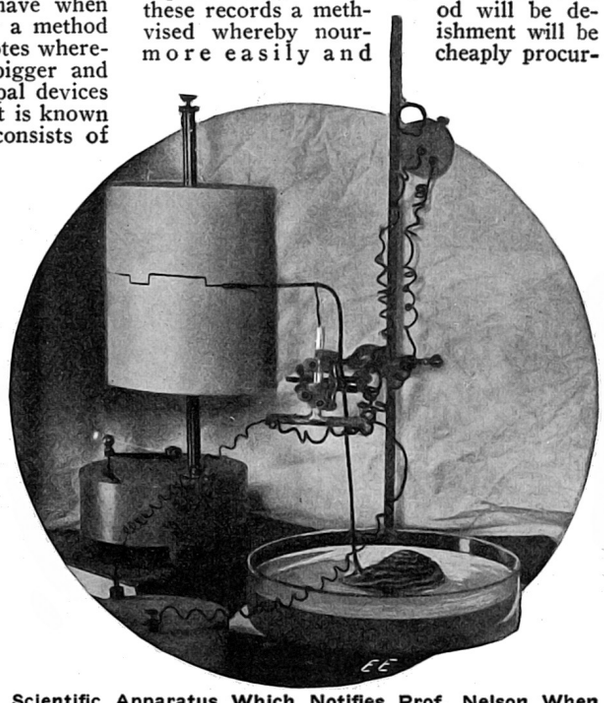
Professor Thurlow C. Nelson, Who Is Making a Scientific Study of the Oyster. He Is Here Seen Wiring an Oyster Preparatory to Feeding It. See Recording Apparatus at Right.

It remained for Professor Thurlow C. Nelson, Assistant Professor of Zoölogy at the State University of New Jersey, to open up a research laboratory in the midst of the oyster beds at Tuckerton, N. J., to perform a series of experiments and studies on the oyster to determine how best to raise a better crop each season. Professor Nelson has fitted out a house-boat in Little Egg Harbor, provided with a number of ingenious contrivances to aid him in gathering a fund of information as to the oyster's routine, particular stress being made on what he normally eats, and the effects that certain foods will have when fed to the bivalves. In this way a method may be determined from these notes whereby we can grow and breed a bigger and better oyster. One of the principal devices used in these experiments is what is known as a standard recorder, which consists of a drum with a cylinder mounted on it, and a cross-sectioned chart paper, on which the oyster records its various minute movements. To the oyster itself a wire is attached, which is connected to the indicator. When the oyster opens, the movement of the shell closes an electric circuit. The indicator or recorder then functions, and the observer can read on the drum the time that it takes to open, how long it remains open, and when the shell closes again!



How the Electric Wire Is Attached to an Oyster's Shell.

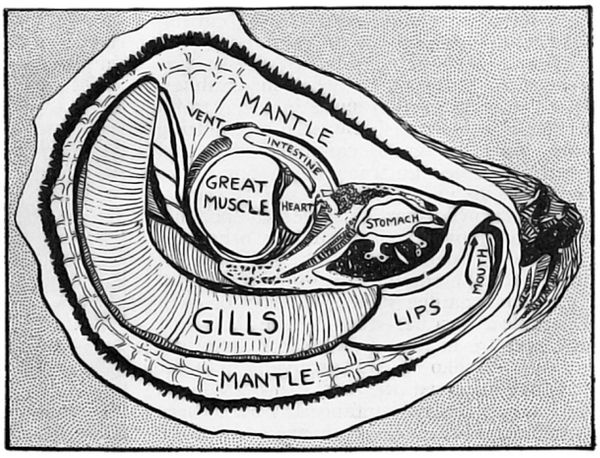
With the closing of this electric circuit, a bell rings notifying the attendant that the oyster is displaying some activity. By means of this apparatus it will be possible to determine the time, day or night, that the oyster feeds, the frequency of these periods and their duration and the kind of food that is consumed over any period. Just what kinds may be learned by removing the oyster from this apparatus and noting its weight after a period of treatment, the weight before going under the treatment being also carefully noted. A microscopic examination of the stomach is then made which shows the contents before assimilation. The rate of growth can also be studied in connection with the effects of artificial feeding. It is a generally accepted fact that it requires three seasons before an oyster reaches market maturity. It therefore becomes obvious that any reduction of this period will result in many advantages to the oyster grower, and also it will mean cheaper oysters to the consumer, with less chance of getting typhoid fever. The U. S. Government has conducted many experiments with oysters in different bodies of water. According to data issued in their bulletins, they have found that many of the tricks of the oysterman have robbed the oyster of much of its nutritive value. Another factor is the danger from disease infection in the waters which are saturated with filth from city sewers. Professor Nelson is now conducting experiments to collect a fund of definite knowledge of the oyster's dietary requisites. From these records a method will be devised whereby nourishment will be more easily and cheaply procurable. The natural flavor variety of oyster will again be restored, and the *drinking* process now used among dealers will be abandoned.



Scientific Apparatus Which Notifies Prof. Nelson When the Oyster Is Feeding and Records the Movement of Its Shell. Electricity Actuates the Instrument.

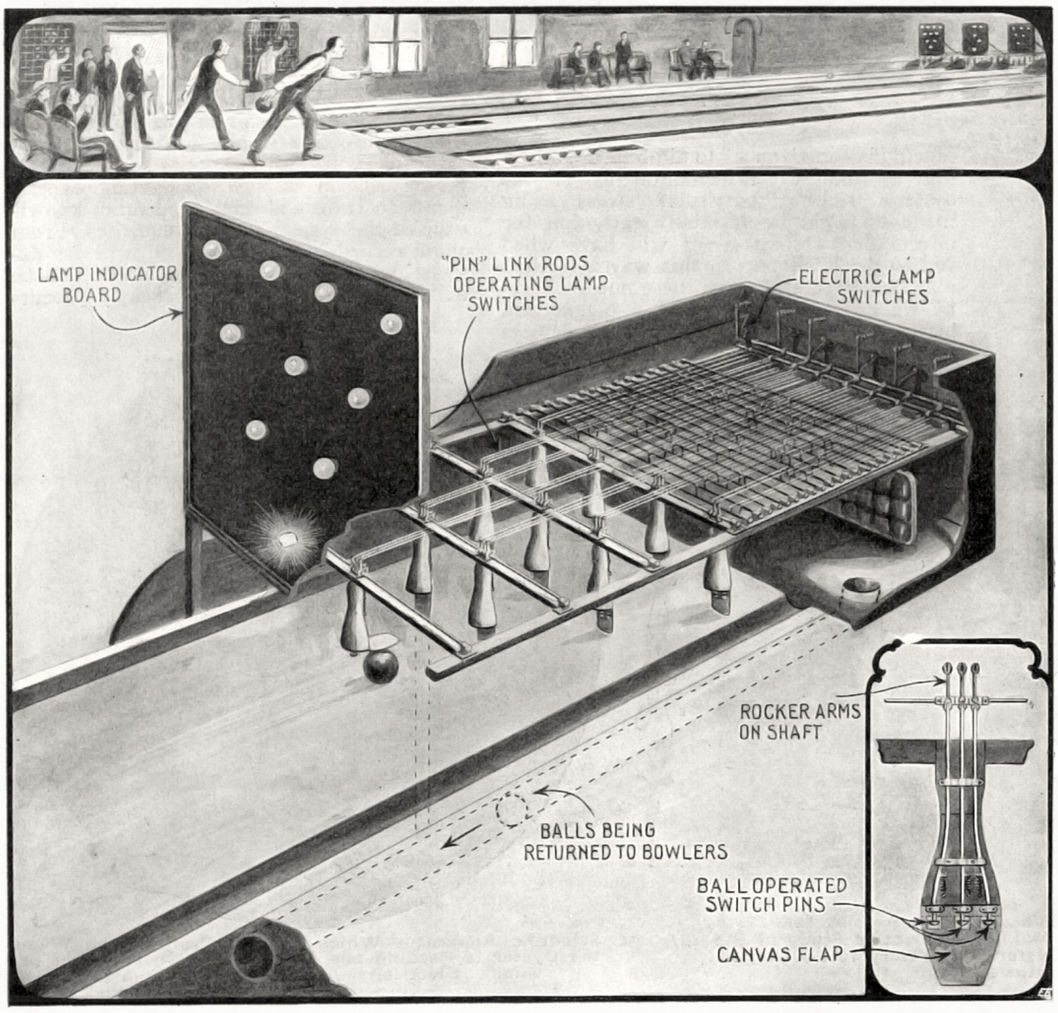
The *drinking* or *plumping* fraud as practised on consumers hoaxes the uninformed into the belief that the resulting bloated whiteness of the bivalves is a mark of par-excellence. As a matter of fact, the oyster so treated loses the greater part of its flavor, and due to conditions under which the trick is carried on, there is the likelihood of its being laden with germs, which may cause serious illness and in many cases death. Thousands of cases of typhoid fever and various other stomach and intestinal troubles result from the con-

(*Continued on page* 244)



The Anatomy of the Oyster—Just Think, Fellow-Banqueters, of All the Wonderful Machinery of Nature We Devour in Every Oyster Cocktail.

Electrifying The Bowling Alley



At Last—Sportsmen—an Electrified Bowling Alley. No Score Keepers, no Pin Boys. Just "Shoot" the Ball Down the Alley. The "Play" is indicated on the Lamp Indicator Board as Here Shown. The Pins Are Self-Resetting.

HATS off to a Milwaukee electrician, Max A. Drews, who has at last come to the rescue of the sporting man, who wonders what science is anyway, with an up-to-date *electrified bowling alley*. Who bowls? The answer is—everybody, in America. So, as we are all interested in bowling, let us take a look at the wonderful invention which Mr. Drews has solved and perfected, which makes it possible at last to bowl all by your lonesome self in your bomb-proof bowling alley down in the basement of your country castle, without the bother of pin boys. In this twentieth century electrified bowling alley *de Luxe*, all the "hits" are chalked up on an electric lamp score-board, automatically—the pins all reset themselves—and the balls, after having wrought more or less terrible havoc among the pin brigade return, thru a gravity conduit, to the bowler's position at the front of the bowling alley.

The details have been worked out very carefully, indeed, by the inventor, so that any regular bowling play is correctly registered on the electric-lamp score-board.

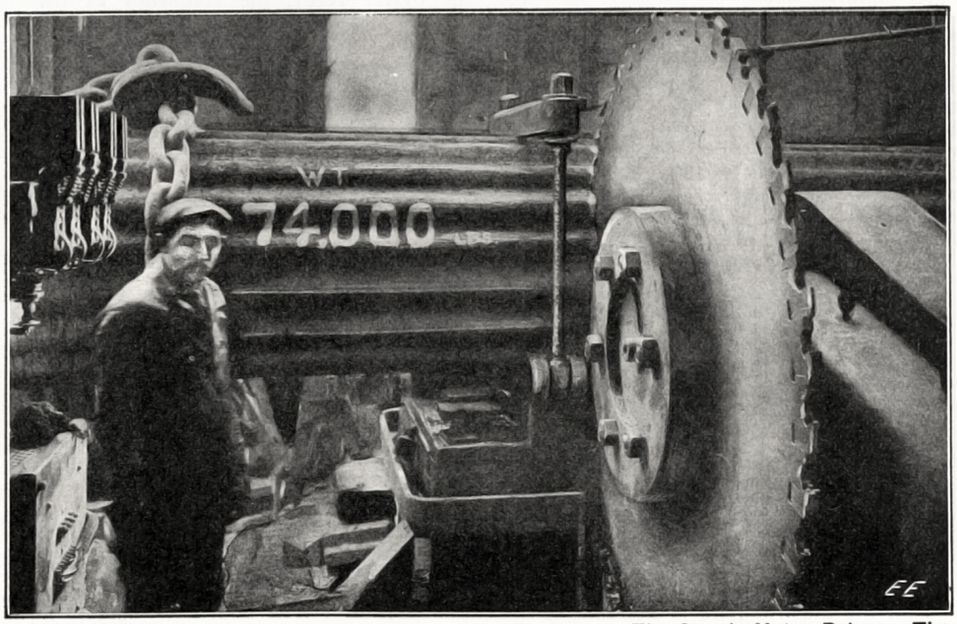
The pins are cleverly arranged and consist of a solid upper member and a canvas or other flexible flap for the lower member, as the detail illustration shows. Generally speaking, there are three electrical contacts and actuating fingers arranged on each pin, one in the center, and one at either side. In the general illustration a ball is shown just passing under the front pin of the set. It will be noted how it passes easily under the upper rigid portion of the pin and presses the flap backwards, without being checked in its onward travel. When the ball, however, passes under the stationary half of the pin, one of the three electrical contact pins is pushed upward, and in doing so it actuates a rocker arm fastened on the cross-wise plates supporting the pins, which in turn connects, thru a wire link, with one of a battery of switches at the rear of the alley, all in the manner apparent. The rear ball pocket of the alley is tapered so that all of the balls, after they have struck the padded cushion, move toward the conduit opening, thru which conduit they travel under the effect of gravity back to the bowling pit at the front of the alley. The lamp score-board is arranged in the formation of the pin set-up, as the illustration shows. It represents one of the cleverest devices ever brought out.

Sawing a 74,000-lb. Steel Ingot

THE accompanying illustration shows a remarkable inserted tooth saw, developed at Pittsburgh, Penna. In the photograph may be seen an 84-inch diameter inserted tooth saw blade, with plate 1 inch thick, and a width of kerf 1½ by 5/16 inches, having a weight of 2,000 lbs., cutting a 35-inch diameter ingot of 31 carbon steel, weighing 74,000 lbs.! Some of these saws are made as large as 90 inches in diameter.

It may be stated that these inserted tooth saw blades are extensively used for cutting ingots, bars, forgings, castings, rails and structural shapes and are made for arbor or sprocket drive machines.

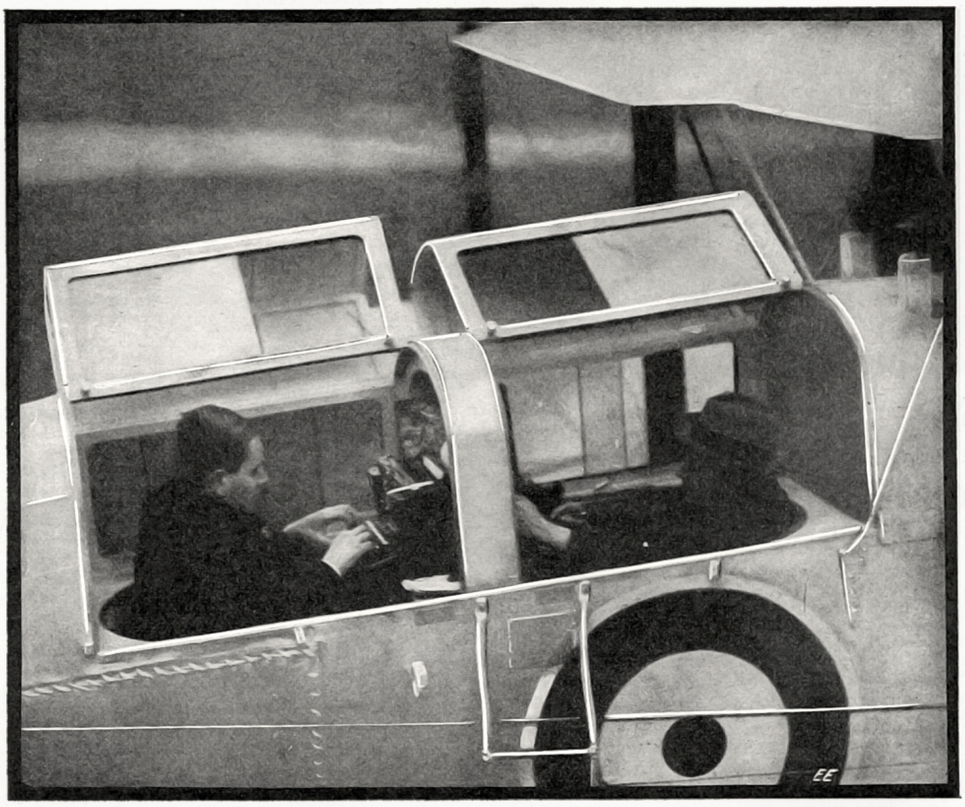
It is claimed that this design permits the use of more teeth than any other inserted tooth blade, and light sections of material can be cut more rapidly than with solid blades, as the rigid construction will withstand a heavier feed. The body of these blades is made of hardened vanadium alloy tool steel, in the grooved slots of which are inserted the best of high-speed steel cutters, treated suitably for all classes of metal cutting. The teeth are secured by interchangeable tool steel wedges and are adjusted from the bottom by hex-head brass screws to obtain correct height when assembling. (*Continued on page* 250)



Sawing a 74,000 Pound Steel Ingot in Half with a Cold Saw. The Saw is Motor Driven. The Saw Teeth Never Touch the Steel—the Air Comprest in Front of the Teeth Does the Cutting.

Typewriting in an Airplane

The photograph herewith demonstrates how the warring countries of Europe are fast adapting themselves to peacetime pursuits, in sport, pleasure and business. This illustration shows what was formerly a powerful French bombing plane converted into a business man's traveling plane, and fitted with an up-to-date office, including a typewriter. Many business men of today do not lose even a moment's time, once they leave their home for the office, and have typewriters fitted in their automobile. One of the leading New York newspaper editors, Arthur Brisbane, has a typewriter fitted in his car, and makes the trip from his home night and morning with his ever-ready "mill" at his side, in the event that he may wish to dash off a new editorial inspiration before it has flown away—unregistered. The same idea of recording thoughts on the wing, as it were, holds as well for business men as for authors and editors. Not only this, but in the spacious airplane cock-pit here shown, the business man using such a modern conveyance to or from business can carry his secretary along.



The Photograph Herewith Shows How a Powerful French Bombing Plane of Large Size Was Converted, After the Signing of the Armistice, Into a Model Business Man's Plane. In the Spacious Cabin of the Plane There Is Ample Room for a Desk and a Typewriter, and the Business Man May Carry His Secretary With Him. The Cock-pit Here Shown Is for Passengers, and Is Separate From the Pilot's Compartment.

Recording Galvanometer and Tuning Fork Timer

An ingenious recording galvanometer and tuning fork timer, as used by the U. S. Signal Corps, is shown in the photograph herewith. The recording galvanometer employs a paper tape, especially prepared by a chemical process, on which the light image reflected from the galvanometer mirror is photographically recorded, and the tape is afterward past thru a chemical bath, which develops the image, similar to the usual photo printing method. Wherever accurate measurements have to be made by means of such a recording device, in which the fluctuations of an electric current are to be recorded in the form of an undulating or wavy line, running along the recording tape, it becomes necessary to accurately space off the tape, so that the time period of each current variation can be readily determined, such as cycles per second, the interruptions of a circuit per second, its frequency, etc.

To solve this problem, use is here made of a simple and yet extremely accurate timer in the form of a musical tuning fork. It is well known that when such a fork is struck by a wooden hammer, that it vibrates with a certain musical note, depending upon the length of the fork and its other physical dimensions. This is the principle upon which the tuning fork timer, which has helped to solve many of Uncle Sam's intricate wire problems in electricity, operates. To one leg of the vibrating tuning fork there is attached an electrical contact which controls a second light image in front of the moving tape and at regular time intervals, this auxiliary timing circuit is closed so as to give spots of light on the paper tape at definite intervals, so that it becomes a simple matter to determine just how many pulsations of the galvanometer string, and in turn the current passing thru it, have taken place in a given space of time. These tuning fork timers are electrically operated in a very ingenious manner. The electromagnet is placed between the limbs of the tuning fork, and by means of a contact placed on one of the limbs, the magnetic circuit is made and broken many times per second, in exactly the same manner as the movement of ordinary vibrating bell functions.

The electrical tuning fork timer, as here described, has been used during the war in solving difficult problems in connection with harbor and coast-defense work, etc. The accurate periodic timing and the closing and opening of an electric circuit by this form of device, have proven very useful in many acoustic or sound problems on which they were engaged to the scientists connected with the Naval Advisory Board and the National Research Council, which covered the recording of sounds from coast defense and warship guns over considerable distances for the purpose of determining by *sound ranging* the distance at which a gun was located when it was fired, etc. Also much study was carried on during the war on the behavior and performance of various calibres of guns by detecting sound and other resultant characteristics whenever the gun was fired. In such work as this, the apparatus here shown, or similar apparatus, proved very useful, and in fact invaluable.

The United States Signal Corps Laboratory developed a great many new and novel instruments during the war. Some of these were not only ingenious and radically new both in conception and design, but marked a new era in scientific apparatus, especially that class of instruments which would lend themselves to use in the field where it is usually considered impossible to design an instrument of extremely sensitive nature, which will possess the proper qualities of high sensitivity and ruggedness so as to withstand rough usage.

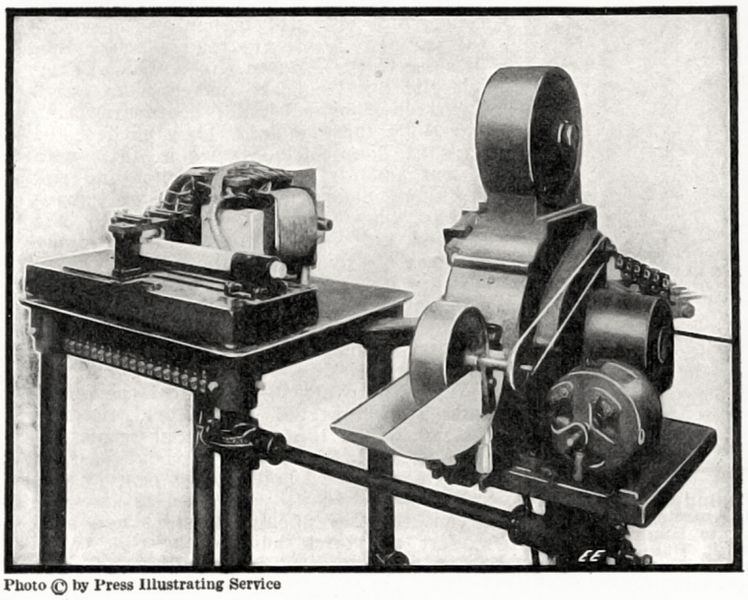
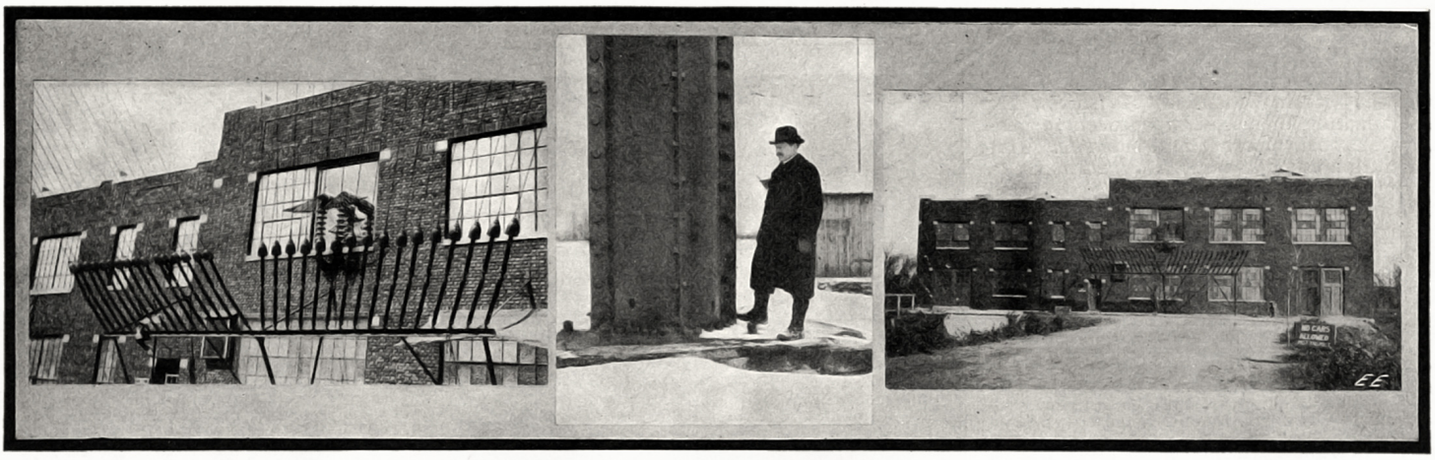


Photo © by Press Illustrating Service

The Accompanying Photograph Shows an Ingenious Recording Galvanometer and Electric Tuning Fork Timer as Used by the U. S. Signal Corps in Studying the Velocity of Sound of Large Guns and for Other Purposes Connected with Harbor and Coast Defence. The Recording Galvanometer Employs a Paper Tape Prepared by a Special Process, On Which the Light Image Reflected from the Moving Galvanometer is Photographically Recorded. The Paper Tape is Afterward Past Thru a Chemical Bath Which Develops the Image in the Same Manner as Photographic Prints Are Exposed and Developed. The Tuning Fork Carries an Electrical Contact On One of Its Prongs, and It is Caused to Vibrate at a Constant Period by an Electromagnet Placed Between the Prongs, the Circuit of Which is Opened and Closed by the Vibration of the Fork Itself.



View at Left—A Close-up of the Thirty-two Wire Antenna Lead-in Entering the New Brunswick Station. Center—Mr. Alexanderson Standing at the Base of One of the 400 Foot Aërial Masts. Right—General View of Antenna Side of New Brunswick Trans-Atlantic Radio Station, Thru Which Station Secretary Daniels Talked by Wireless Telephone to Europe.

"Hello Europe"—Via Radio

By CHARLES M. RIPLEY

The powerful wireless telephone and telegraph plant at New Brunswick, N. J., described in full detail by an engineer who visited the plant—Why "N. F. F." (New Brunswick's call) called "P. O. Z." (Nauen, Germany), in war time—How the voice of Secretary of the Navy Daniels was wafted thru space over 2,000 miles by wireless to President Wilson, on board the "George Washington" in Brest Harbor, France—How the voice starts with an initial energy of one one-thousandth watt, which is amplified and boosted thru marvelous apparatus until it leaps forth from the 32-wire, mile-long antenna intensified 100,000,000 times, with the power of 270 horses or 2,700 men, a great, turbulent, seething mass of noiseless electrical energy, which shoots thru the earth and air at a speed of 186,000 miles per second! A modern express train, traveling at a mile a minute, is like the lowly snail by comparison.

WITH the outbreak of war an impenetrable curtain of censorship was dropt between the public and many of the world's activities. But, at fever heat, like the stage hands in the cosmic theatre, the world's scientists and inventors have been surpassing themselves in setting the stage for the showing of a new scene.

The Curtain Rises.

Now the curtain begins to rise on this new scene which will tell us a romantic story of accomplishment, out-rivalling the imagination of a Jules Verne. It discloses a great transoceanic wireless telegraph station, providing daily communications direct to our armies, with our Allies in London, Rome and Paris—and, what is most surprising of all, our *communication direct to Germany.*

Late in October, 1917, the Washington key which actuates the great wireless station in New Brunswick, N. J., clicked off

. - - . - - - - - . . - . . . - . . . - . . . - .

This translated from the telegraph code into the alphabet reads:

P — O — Z — DE — N — F — F

And then in quick succession:—

"POZ—POZ—POZ— de —NFF—NFF—NFF"

This fairly electrified the men in the station: "Washington is calling Germany direct" — SOMETHING EXTRAORDINARY!!!

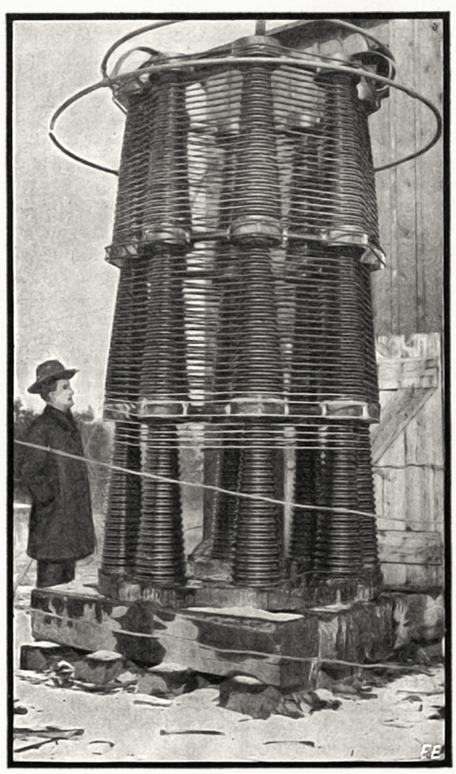
"POZ" is the call for the Nauen station in the outskirts of Berlin, and "de NFF" meant "from New Brunswick, U. S. A." Thus all diplomatic precedents had been shattered by direct communication between two nations at war! Shortly the message came from Nauen that they were in receipt of the call, and according to gossip the German operator said, "Your signals are fine, old man."

Then followed the historic note of President Wilson demanding the abdication of the Kaiser, stating that the American Government will not negotiate with any but the German people direct. So, from the very beginning, the negotiations leading up to the armistice were conducted thru the New Brunswick, N. J., Naval Radio Station.

Other achievements of this station are numerous; out of 44,640 minutes in the month of January, 1919, the New Brunswick station in the 41,961 minutes of its operation rendered some of the following services:

First—Every day New Brunswick communicated with San Francisco and San Diego, Cal.

Second—Every day New Brunswick communicated with Admiral Sims' flagship in British waters.



One of the Gigantic Tuning Coils Used on the "Multiple Tuned Antenna" Devised by Mr. Alexanderson, the Engineer Who Developed Trans-Atlantic Radiophony to a Practical Basis.

Third—Every day New Brunswick signals are received in Paris, Rome and Wales.

Fourth—So clear are these signals that the ordinary receiving sets on battleships in various parts of the world get these messages. It has been frequently reported that the small portable field sets in France have received the New Brunswick messages.

Fifth—For practically a year a daily International Press service was transmitted thru this station; thereby making American opinion known all over the world—particularly among Germany's dissatisfied allies.

Sixth—Secretary Daniels "spoke" to President Wilson thru the New Brunswick station while on board the *George Washington* in the middle of the Atlantic Ocean.

Seventh—And the wireless telegraph of the "George Washington" receives New Brunswick messages continually and keeps President Wilson informed of world and home events while on the high seas.

Such is the work done by this station.

Here is the stage-set, the curtain of censorship lifts still higher and discloses the station. A country road which swings in close to the Raritan River, which parallels the old Delaware and Raritan canal. Two old-fashioned canal boats are being towed by three mules. They suggest the days of hoop-skirted ladies in 1812, with ardent gallants in knee breeches and silk stockings dancing attendance and quadrilles. The effect is heightened by the stooped old gray-haired driver, trudging thru the red mud beside the horses.

In the distance are seen the thirteen giant 400-foot steel towers of the U. S. Naval Radio Station piercing the sky—their insulators glistening in the Spring morning's sun.

What a contrast—the most powerful radio station in the New World, flashing messages thru the skies to our armies in Europe, and the old canal boat passing close to the weird building. A century and a half stretched its wonderful history between that old unpainted barge and this modest red brick building bristling with

(*Continued on page 262*)

"HELLO EUROPE"—VIA RADIO

How Secretary of the Navy Daniels' voice was hurled by wireless telephone across the broad expanse of the Atlantic Ocean to President Wilson who was on board his ship, the "George Washington," in Brest Harbor, a distance of 3,000 miles.

TELEPHONE EXCHANGE

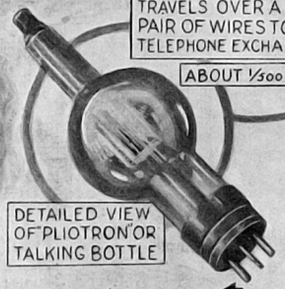
VOICE CURRENTS TRAVEL OVER CIRCUIT TO RADIO STATION

TELEPHONE TRANSFORMER

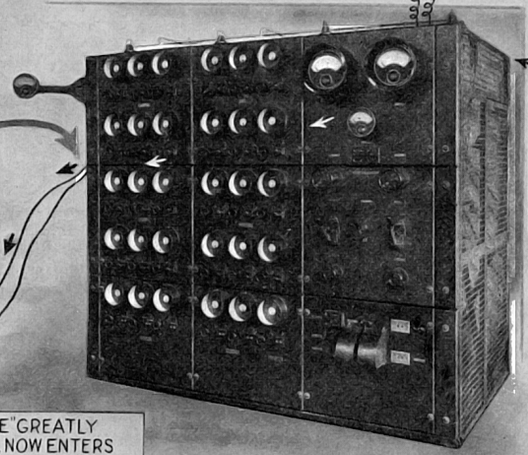
TALKING TO AND FROM AIRPLANES

THE HUMAN VOICE TRAVELS OVER A PAIR OF WIRES TO TELEPHONE EXCHANGE

ABOUT 1/500 H.P.



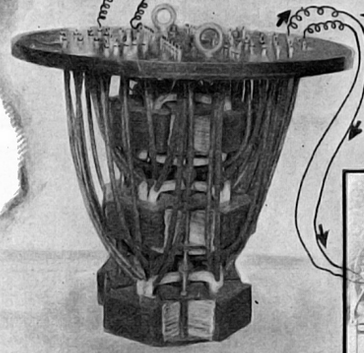
DETAILED VIEW OF "PLIOTRON" OR TALKING BOTTLE



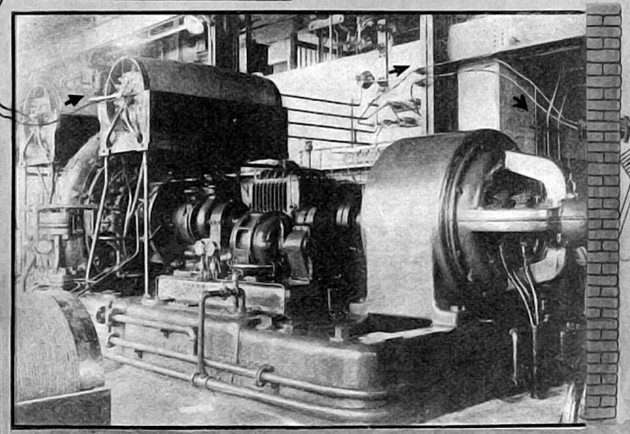
MILD VOICE CURRENTS ENTER AMPLIFYING SWITCH BOARD PASS THRU BANK OF THIRTY "PLIOTRON" BULBS (TALKING BOTTLES AND EMERGE INTENSIFIED TO SEVERAL HUNDRED WATTS!

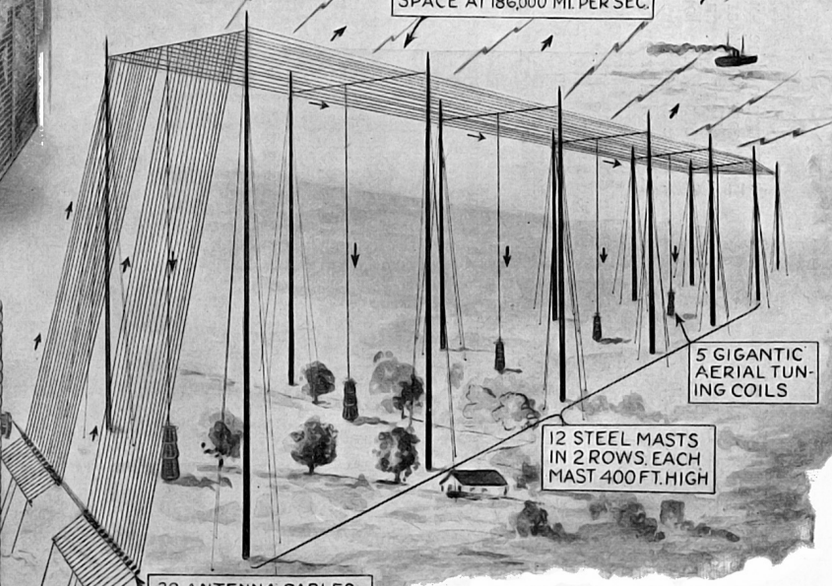
SECY. OF THE NAVY DANIELS SPOKE TO PRES. WILSON ACROSS THE ATLANTIC OCEAN

HERE'S YOUR VOICE, MULTIPLIED 100,000,000 TIMES, SHOOTING THRU EARTH & SPACE AT 186,000 MI. PER SEC.



YOUR "VOICE" GREATLY AMPLIFIED, NOW ENTERS THE MAGNETIC AMPLIFIER AND COMES OUT STILL MORE POWERFULLY INTENSIFIED





5 GIGANTIC AERIAL TUNING COILS

12 STEEL MASTS IN 2 ROWS. EACH MAST 400 FT. HIGH

32 ANTENNA CABLES BUNCHED AND LEAD INTO STATION THRU PLATE GLASS WINDOW

ANTENNA 1 MILE LONG

HERE YOUR VOICE CURRENTS, ENTER THE CONTROL WINDINGS WHICH REGULATE THE OUTPUT OF THE ALEXANDERSON 200 K.W. (270 H.P.) ALTERNATING CURRENT DYNAMO

The Accompanying Article Explains the Details of the Apparatus Shown in the Illustration Above. The Majority of This High Power Radio Apparatus Has Been Under Secret Development During the War. As Will Be Evident Upon Inspection of the General Illustration Above, Secretary Daniels' Voice Was Carried Over the Telephone from Washington Thru a Telephone Exchange and Then Entered the Great Radio Station at New Brunswick, N. J.

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A 100 Horse-Power Voice

By JEFFERSON WILLIAMSON

A PRACTICALLY unlimited range for the voices of orators addressing outdoor crowds is now made possible by the introduction of what is called the *loud speaking* telephone. This device was used by speakers thruout the recent Victory Liberty Loan Campaign at "Victory Way" in New York City. "Victory Way" was a section of Park Avenue, five blocks in length, just north of the Grand Central Terminal. It had been specially decorated and otherwise elaborately fitted up as a "show place" which was meant to be the center of outdoor activities on behalf of the sale of Victory Notes. Each day several programs were presented at the "Way" and by means of the loud speaker the orators and musical entertainers were distinctly heard at all parts of the "Way," regardless of the fact that the line of fire of the voice of the average orator normally is only about eighty feet. In other words, without the loud speaker, the average orator could convey his ideas at a closely packed outdoor meeting to only about *five thousand* persons. The loud speaker, with its five-block range, made it possible for *tens of thousands* of people to hear the voices of the speakers intelligently.

But the range of the loud speaker is practically limitless. The farther in any direction your audience extends, the more telephone receivers of the loud speaker variety you use. The size of the audience does not matter if the orator speaks clearly and distinctly, and an orator is not an orator unless he does so speak.

Mrs. Carter Glass, wife of the Secretary of the Treasury in Washington, D. C., was the principal speaker at the opening ceremonies of "Mothers and Wives Day" at "Victory Way." Mrs. Glass spoke over the long-distance telephone from the Capitol and her words were distinctly transmitted to every person on the "Way" by means of the great receivers hung at intervals over the heads of the crowd. Mrs. Glass was followed by Mrs. Vincent Astor, who spoke from the platform at "Victory Way" into the transmitter, which carried her words to every woman in the crowd.

The crowds in "Victory Way" were thrilled one night by speeches from officers in the Great Naval Dirigible 34, which flew over the Way from the station at Rockaway Point. The words of the man in the air were carried distinctly to the waiting throngs thru the receivers of the wireless telephones overhead.

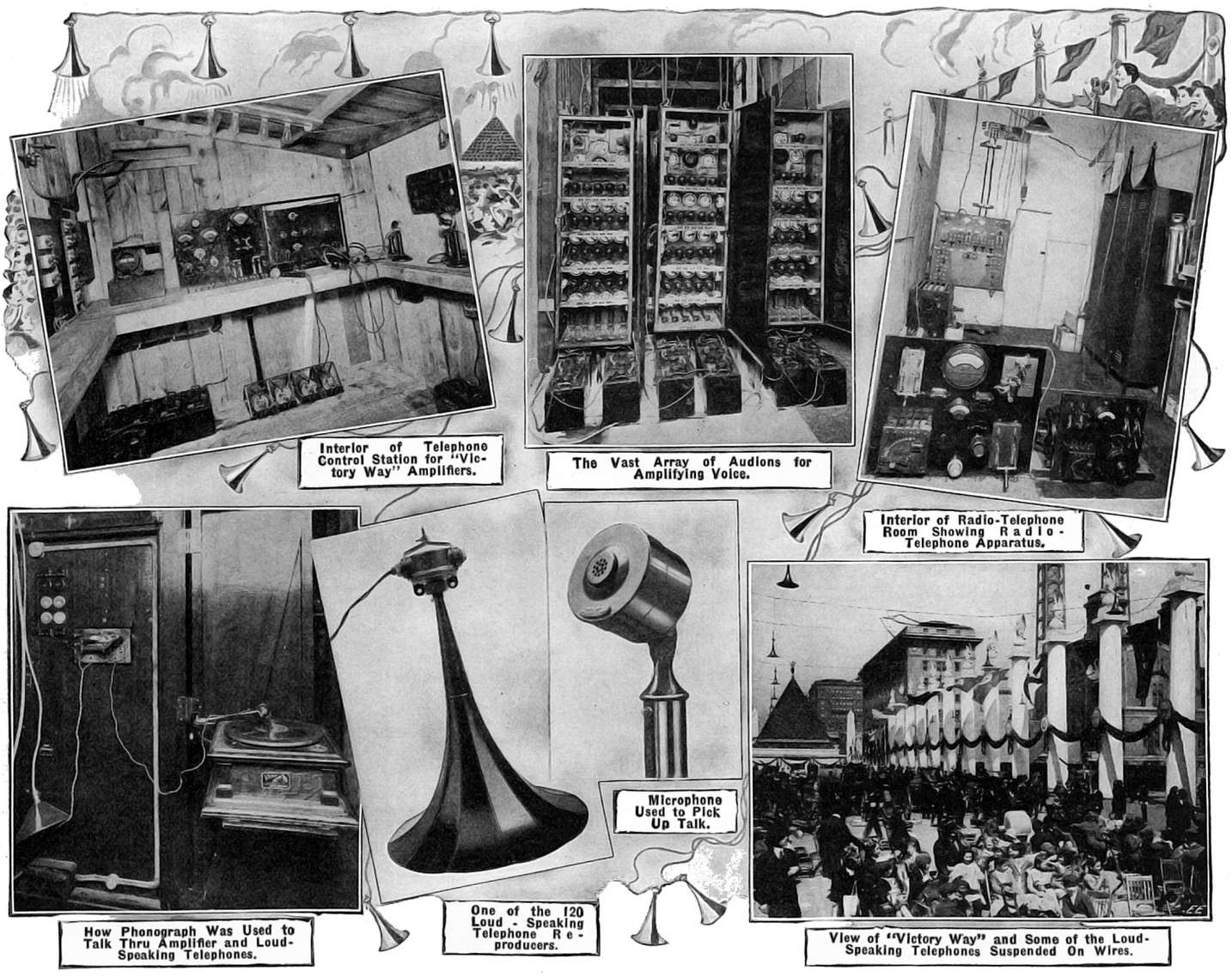
"Hello," came the message from Lieutenant Gilbert Douglas in the airship.

"Hello," was the answer from the speakers' platform, while every person on the Park Avenue plaza hurried to join one of the groups under the receivers.

"We hope every man and women in 'Victory Way' will buy a Victory Note," was Lieutenant Douglas's parting message as the great aircraft turned her course homeward.

It is not necessary for the orator to be in front of his audience. He can be hundreds of miles away and yet be heard distinctly. For instance, each day the crowds on "Victory Way" heard at least one address transmitted from Washington. Among these speakers were Secretary of War Newton D. Baker, General Peyton C. March, and other high governmental officials. And at the close of their addresses the speakers in Washington were able to hear the applause of the New York crowds at "Victory Way." Also, a message delivered by wireless telephone from the U. S. Dirigible C-4, of the Rockaway Naval Air Station, as it hovered five thousand feet high over the East River, was transmitted to all parts of "Victory Way" by means of the loud

(*Continued on page* 255)



Interior of Telephone Control Station for "Victory Way" Amplifiers.

The Vast Array of Audions for Amplifying Voice.

Interior of Radio-Telephone Room Showing Radio-Telephone Apparatus.

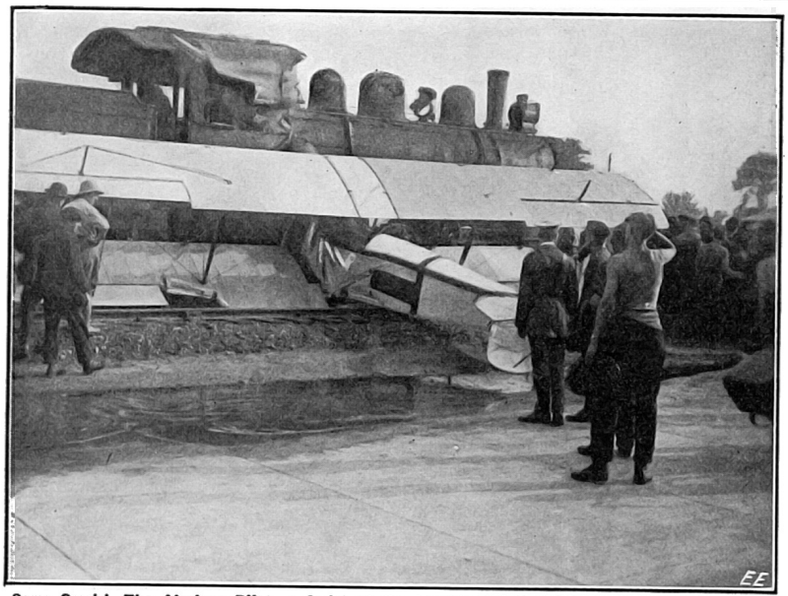
How Phonograph Was Used to Talk Thru Amplifier and Loud-Speaking Telephones.

Microphone Used to Pick Up Talk.

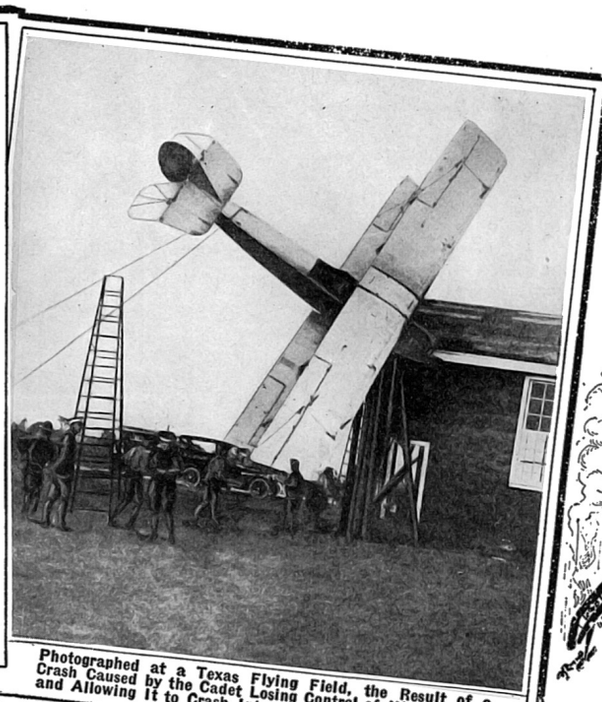
One of the 120 Loud-Speaking Telephone Reproducers.

View of "Victory Way" and Some of the Loud-Speaking Telephones Suspended On Wires.

Disastrous Airplane Crashes

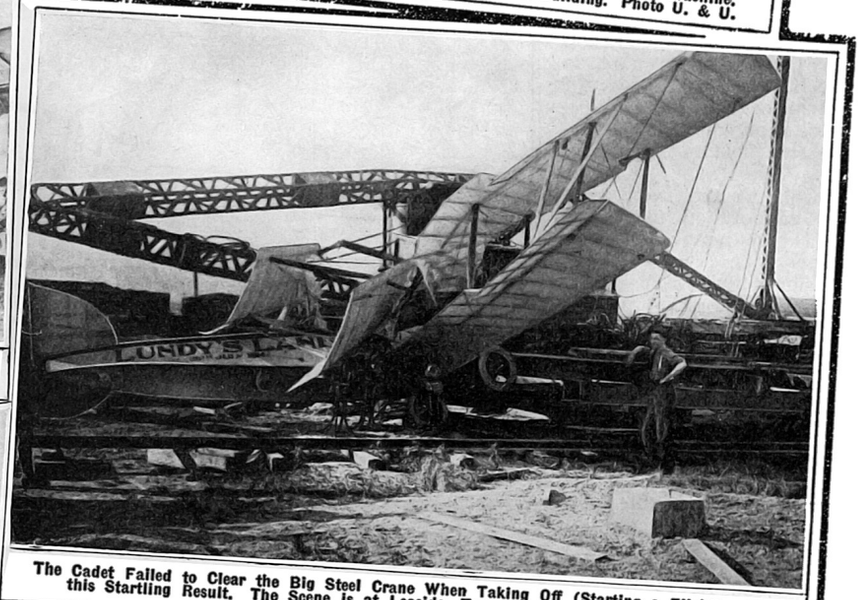


Some Crash! The Airplane Pilot—a Cadet at the Leaside Aviation School, Near Toronto, Can., Was Trying to Land. He Hit the Locomotive and Then He Landed Quickly.



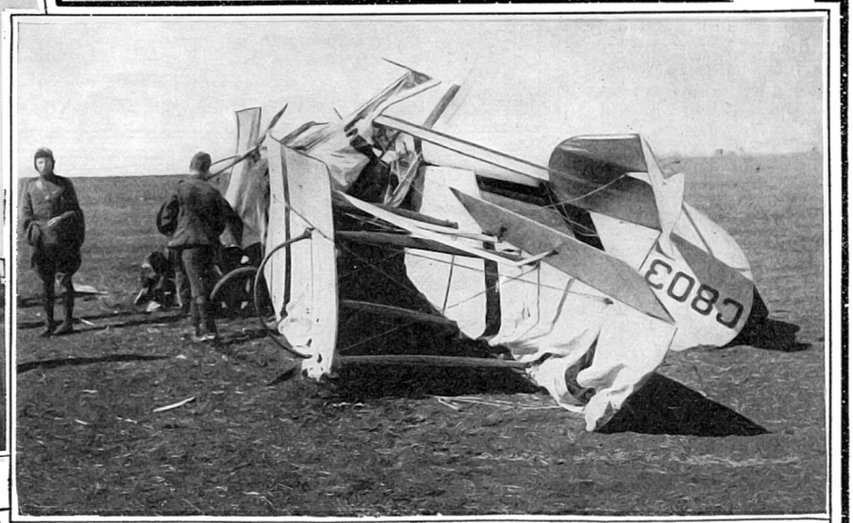
Photographed at a Texas Flying Field, the Result of a Crash Caused by the Cadet Losing Control of His Machine, and Allowing It to Crash Into a Building. Photo U. & U.

A Fatal "Nose Dive" of 2000 Feet. Engine Undamaged But Pilot Killed. Blood Stains On Left Wing. Photo Frank Hall.

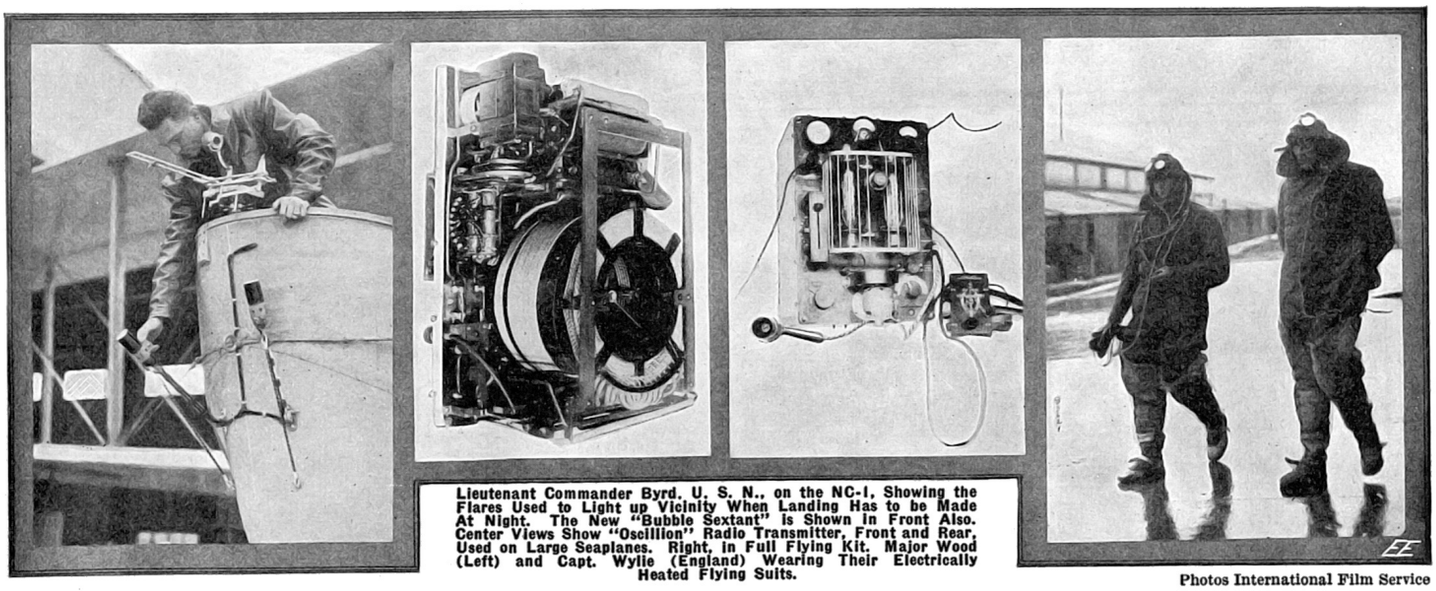


The Cadet Failed to Clear the Big Steel Crane When Taking Off (Starting a Flight) with this Startling Result. The Scene is at Leaside, Toronto, Canada. Photo U. & U.

The Wreck of a Small Seaplane which Crashed Into a Tank of Hydrogen at Rockaway, L. I., May 6th. The Two Aviators, Were Instantly Killed. Photo © by Press Ill. Ser.



Another Fine Crash at an Illinois Flying Field. 'Plane Fell 200 Feet While Piloted by Student Aviator. It Turned Over After Landing. Photo Frank Hall.



Lieutenant Commander Byrd, U. S. N., on the NC-1, Showing the Flares Used to Light up Vicinity When Landing Has to be Made At Night. The New "Bubble Sextant" is Shown in Front Also. Center Views Show "Oscillion" Radio Transmitter, Front and Rear, Used on Large Seaplanes. Right, in Full Flying Kit. Major Wood (Left) and Capt. Wylie (England) Wearing Their Electrically Heated Flying Suits.

Photos International Film Service

Flying Across the Atlantic

By H. WINFIELD SECOR

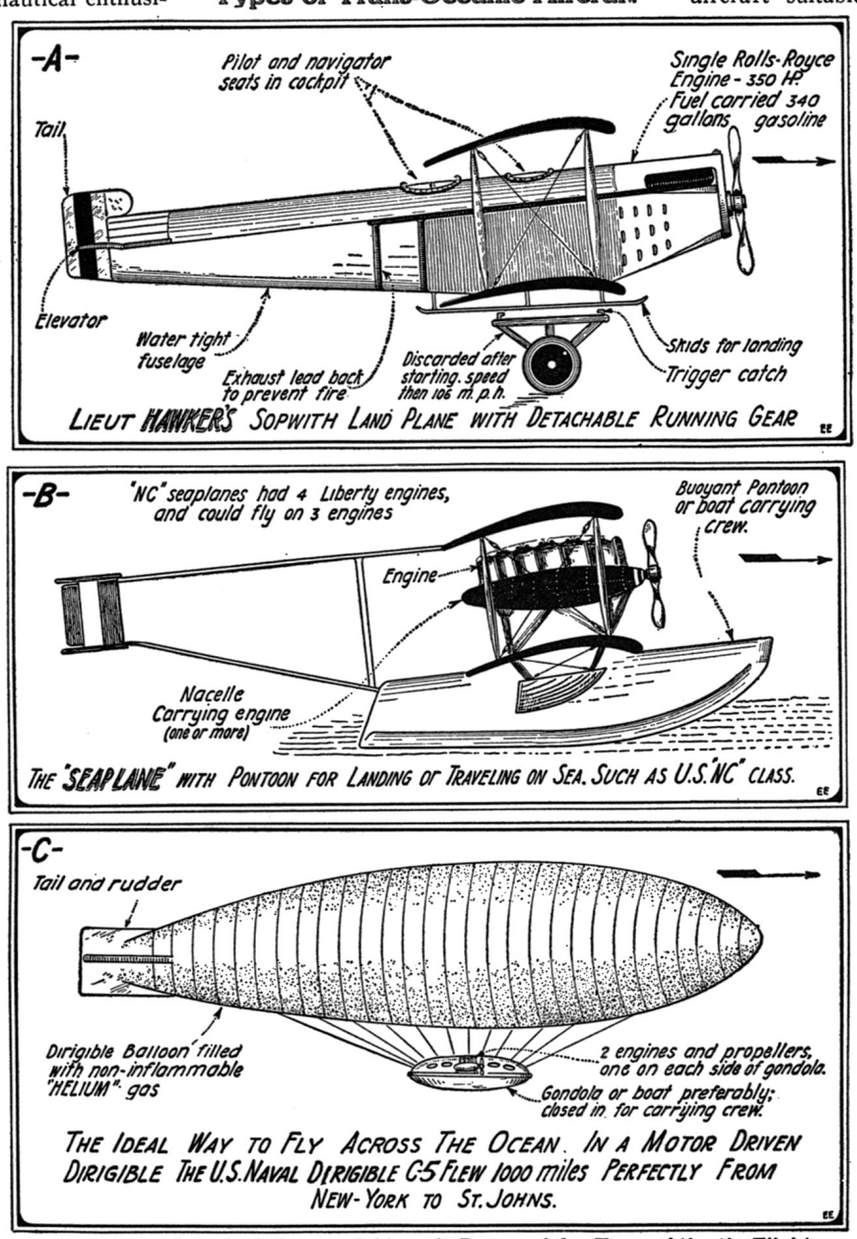
TRANS-ATLANTIC flying has been a dream among aëronautical enthusiasts for many years, and we of the present generation are indeed fortunate in seeing this great feat of aërial engineering and exploitation carried to a successful conclusion by the U. S. Naval seaplane NC-4. At the same time we cannot help but pause and give honor to Lieut. Harry G. Hawker, the daring young English pilot who undertook to fly the Atlantic Ocean over a course which was not even covered by the regular ocean steamships, let alone marked by even a single English naval or other ship. Hawker demonstrated that he had unlimited faith in his machine, which was shared by his navigator, Lieut. Commander McKenzie Grieve, R. N. This trip as planned averaged from 1850 to 2000 miles, and was to have required from 22 to 26 hours of flight.

In considering the trans-Atlantic flight we are, after a little philosophizing on the subject, bound to be confronted with the three principal methods of crossing such a great span as this, i.e., with respect to the type of machine which should be employed. The U. S. Navy has shown that its undoubted faith in the large pontoon form of seaplane was based on sound logic and correct scientific design. As an example of the efficiency of this type of flier for such form of travel over vast water distances, the NC-3 has shown that it can land on the ocean and stand considerable buffeting about without sinking for several days.

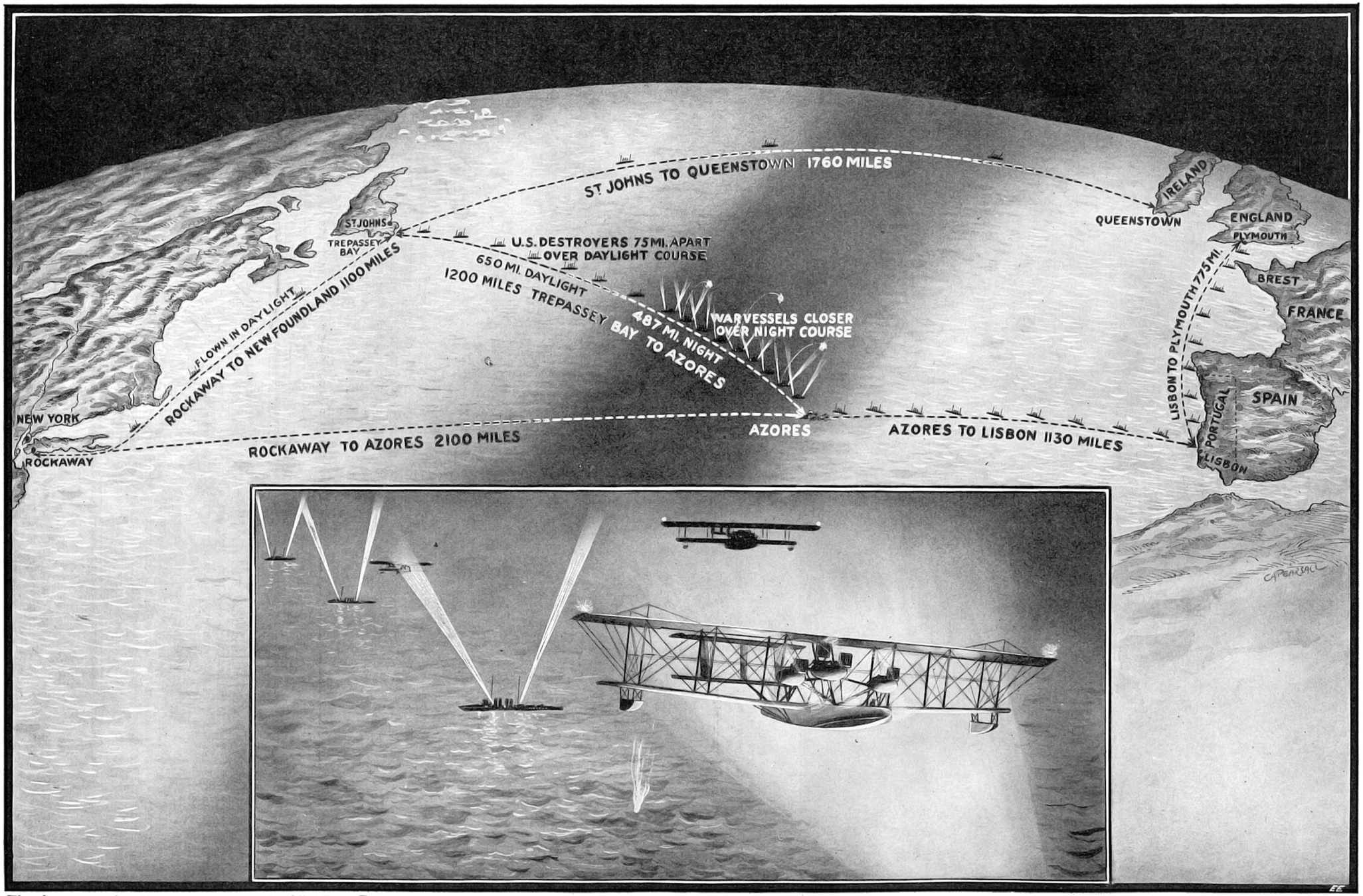
Types of Trans-Oceanic Aircraft

Let us take up the three distinct types of aircraft suitable for trans-Atlantic flight, each of which has been or soon will be tried for bringing the Old and New Worlds closer together. The first type we will consider principally because it seems to have a slight chance of carrying its passengers safely across the 2000 miles of watery deep, is that employed by Hawker and his navigator, Grieve. Lieut. Hawker's airplane was, to begin with, of the *land-going type* and not adapted in any way to oversea travel. Many people have asked why he should have ever thought of starting out with a 'plane of this type on such a long and hazardous trip over the vast ocean span, on the greatest aërial feat ever attempted in the history of flight by man. The reason for choosing this form of 'plane was, primarily, that he was thoroly familiar with it from considerable war experience in Europe, and also there was no useless weight being carried such as is occasioned when any form of pontoon is attached. Lieut. Hawker had the right theoretical idea, but he carried it too far, it would seem to us now. Not only did he choose a land-type 'plane, but he had the under-running gear, comprising the cradle and wheels on which the 'plane traveled over the ground in starting, specially arranged with a trigger release device, so that once he got in the air and started oceanward he could, by the pull of a lever, disengage the running gear so as to reduce the weight of the 'plane

(*Continued on page* 245)



The Three Principal Forms of Aircraft Proposed for Trans-Atlantic Flight.



The Accompanying Illustration Shows Us Vividly a Few of the Outstanding Features of a Trans-Atlantic Flight—the Greatest Aërial Feat of the Age. Like Columbus When He Set Out to Discover New Lands, with His Three Tiny Ships, So the U. S. Naval Birdmen Flew Away from Trepassey Bay on the Afternoon of May 16th. Of the Three Giant Seaplanes to Start, the NC-4 Alone Completed the Trip on Schedule. The NC-1 Was Forced to Land on the Water—the Crew Was Picked Up by a Vessel. The NC-3 Also Landed on the Water Due to the Heavy Fog and After a Day and a Night of Floating on the Water, It Came Into Ponta Delgada, Azores, Under Its Own Power. The NC-4, the First Heavier-Than-Air Flying Machine to Cross the Atlantic Ocean, Will Undoubtedly Be Preserved and Placed on Exhibit in the Smithsonian Institution at Washington, D. C. The NC-4 in Its Flight from Trepassey Bay to Lisbon, Portugal, Covered a Distance of 2,150 Nautical or 2,506.9 Statute (Land) Miles in 26:47 Hours actual Flying Time, or at an Average Speed of 80.3 Nautical Miles. The Three Seaplanes Left Trepassey at Sunset on May 16, and the NC-4 Reached Lisbon Soon After Noon on May 27, the Eleventh Day After Its "Hop" from Newfoundland. The Official Trans-Atlantic Flight Ended with the NC-4's Arrival at Lisbon. The NC-4 and Her Original Crew Then Proceeded to Plymouth, England, Where They Were Officially Congratulated and Welcomed.

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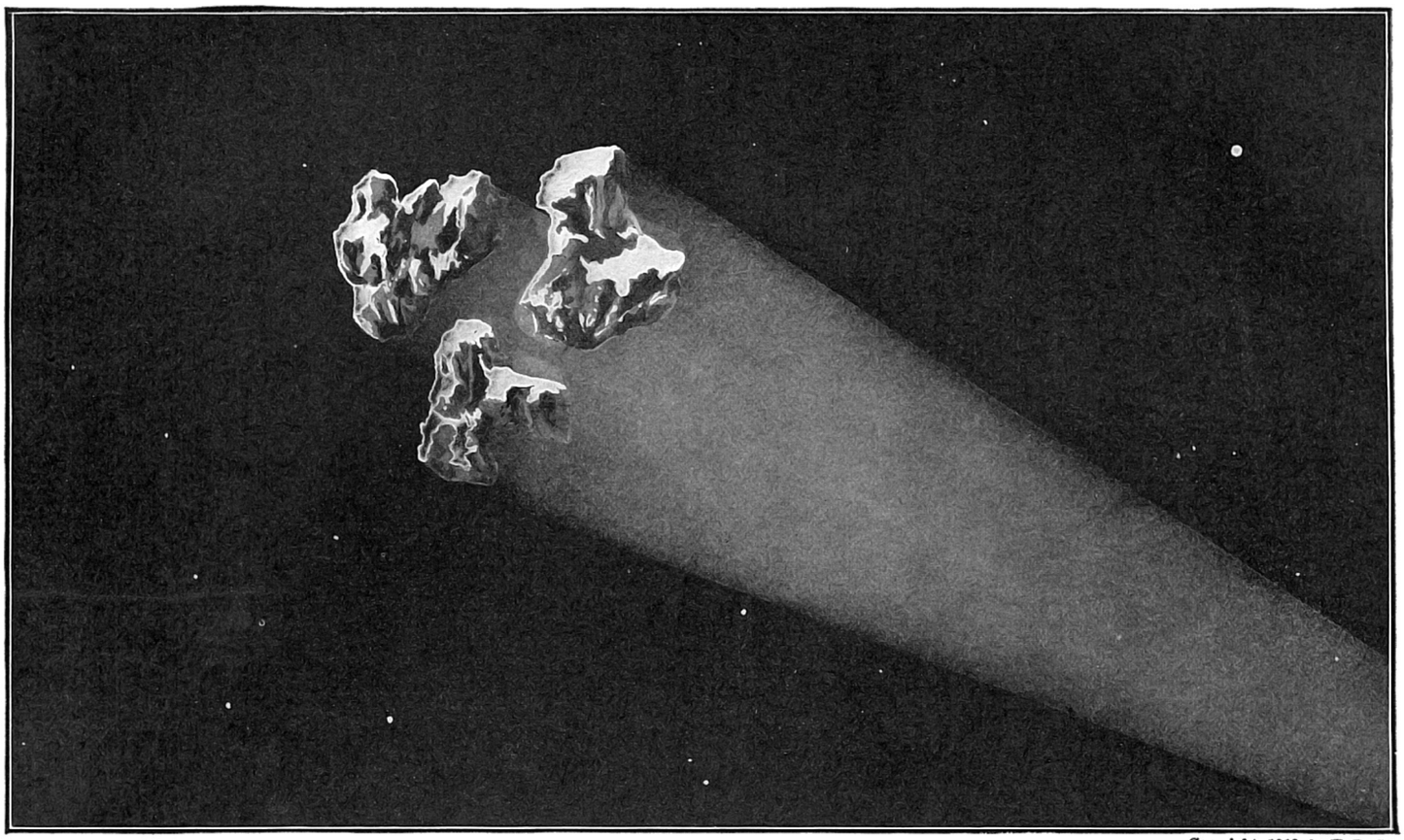

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For a Long Time Astronomers Have Been Puzzled on Account of the Variability of the Light of Many of the Asteroids. These Small Heavenly Bodies Measuring an Average from 3 to 5 Miles in Diameter Are Nothing But Huge Rocks Hurtling Thru Space Along Well Defined Orbits. It Is Now Believed That the Variability of the Light Is Caused by Two or Three Asteroids, Very Close Together, Revolving Among a Common Center. Our Artist Has Shown in This Illustration How a Small Cluster of These Asteroids Would Appear When Viewed from a Distance of About Ten Miles. The Three Bodies Shown Average from 3 to 5 Miles in Diameter.

Popular Astronomy

By ISABEL M. LEWIS

Of the U. S. Naval Observatory

Astronomical Facts For All

FOR the past year Mrs. Lewis has presented a series of very fine astronomical articles to the ELECTRICAL EXPERIMENTER. We are happy to say that we have renewed our arrangement with Mrs. Lewis for another year, and we believe that our readers will welcome the announcement.

In the past Mrs. Lewis has written a monthly article covering only one subject. For the coming year, this arrangement will be slightly changed, and we will endeavor to show every month a variety of articles—"Astronomical Facts for All." In addition to this, we have opened a Question and Answer department which is starting in the present issue. We invite our readers to send in their questions on astronomical subjects which Mrs. Lewis will answer monthly.—EDITOR.

1. Asteroids and How They Are Discovered.

ONE is apt to picture the asteroid seeker painstakingly sweeping the heavens with his telescope to discover a new asteroid or comet. As a matter of fact astronomers spend very little time searching for new asteroids or comets these days when so many other problems are demanding attention. These heavenly bodies are now usually picked up photographically.

The comets are always welcome and interesting visitors, the discovery of a new asteroid is not apt to arouse any marked enthusiasm in the astronomer's heart, despite the fact that occasionally an asteroid has turned out to be an important tho tiny member of the sun's family—as, for instance, Eros, an asteroid only a few miles in diameter that comes within thirteen million miles of earth at times and therefore furnishes a very valuable means for determining the distance of the earth from the sun. Approximately one thousand asteroids have now been discovered, and to name and keep track of these troublesome little members of the sun's family is a tremendous task, especially since they are subject to so many perturbations from the larger members of the sun's family, in particular Jupiter. It is only the hope of finding out a few valuable facts from the exceptional asteroids that keeps the astronomers at the task of caring for this troublesome family of asteroids.

If a photographic plate is fastened to the eye end of a telescope and the sidereal clock work of the telescope started so that the telescope will follow the stars, the stars will be immovable in the field and their images will be sharp points of light on the plate, but any object within the field of view that is moving relative to the earth will leave a short trail of light on the plate owing to its motion during the period of the exposure of the plate, which is usually two or three hours.

Practically all asteroids and all periodic comets whose returns are predicted are discovered by this method. Whether the body is a faint comet or an asteroid, additional plates and an approximate computation of its path will decide.

The four largest asteroids, Ceres, Pollas, Vesta and Juno, are respectively 485, 304, 243 and 118 miles in diameter. These are the values found by Barnard as a result of measurements with the 36-inch telescope of the Lick Observatory. A few more of the asteroids may exceed one hundred miles in diameter, but the great majority are simply huge rocks five miles or less in diameter. These small bodies have such a weak gravitational attraction that they are unable to hold an atmosphere and as a result there can be no form of life, either animal or vegetable, on even the largest of them.

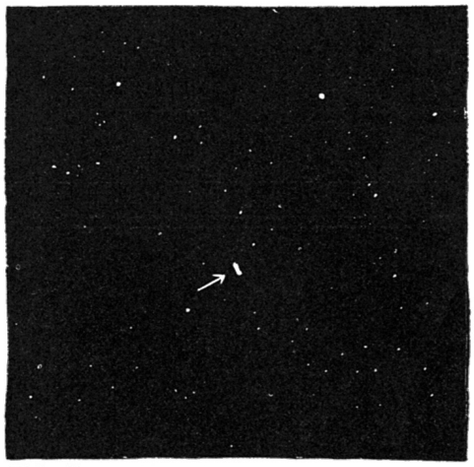
Various estimates have been made of the total mass and bulk of the asteroids. Their average density has been estimated as about equal to that of the earth's surface crust. The great mathematician and astronomer, Leverrier, the discoverer of Neptune, proved that the total mass of matter between the orbits of Mars and Jupiter, where the asteroids are to be found, could not exceed one-fourth of the earth's mass, and later computations reduced this to one-one hundred and fifteenth of the earth's mass. As the combined mass of all the asteroids so far discovered falls far below this value there are probably thousands of small asteroids still undiscovered, tho it is very unlikely that any asteroid whose diameter exceeds one hundred miles has escaped detection.

As the mass of Mars is about one-tenth

and the mass of Mercury about five one-hundredths that of the earth, it is evident that all the asteroids combined could not furnish enough material to fashion a planet that would approach even the smallest of all the planets, Mercury, in size.

The orbits of the asteroids differ greatly in size and form and in inclination to the ecliptic. Some are almost perfect circles, others greatly elongated ellipses. Their inclinations to the plane of the earth's orbit vary from zero to thirty-five degrees. In this respect they differ greatly from the orbits of the planets which lie very nearly in the same plane.

It has been suggested that variability in the light of many of the asteroids may be due to a difference in the reflecting power of different portions of their surface or to irregularities of form. Unlike the major planets, the asteroids are not spheres but simply jagged rocks, huge mountains hurtling thru space, whirling round and round on their axes as they journey about the sun. Possibly, as some have suggested, they may be the larger fragments of periodic comets of unusual size that have in the course of ages been shorn of their appendages. This might account for the suspected existence of double or multiple asteroids, in which two or more of these huge rocks are grouped so closely together as to appear as one in the telescope. This would also account for the variability in the light of some of the asteroids.



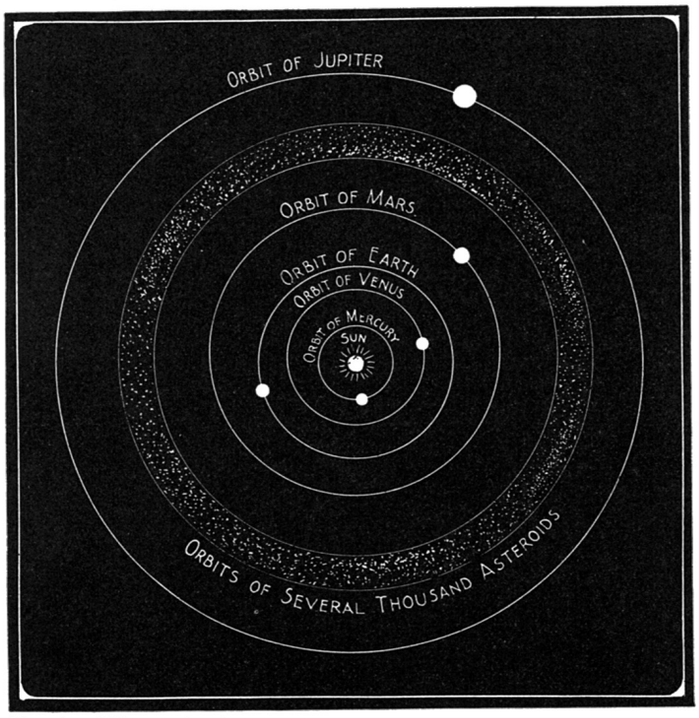
This Shows How Asteroids Are Discovered, Not Thru the Telescope, But on the Photographic Plate. The Stars Standing Still, Any White Streak Left on the Plate Must of Necessity Be Either a Planet or a Comet.

2. Shooting Stars.

"SHOOTING stars" is an unfortunate name for the small masses, weighing usually only a few ounces, that enter the earth's atmosphere from outer space, are ignited by friction with the atmosphere, glow brightly for a few brief seconds and then fall to the surface in the form of dust.

It has been estimated that shooting stars or meteors, as they are more fittingly called, enter the earth's atmosphere by the millions every day, only a very small percentage of them being visible to the naked eye at any one place. They fall by day and by night, over land and sea, in polar regions and in the tropics. The snowy wastes of the far north are dusted with the ashes of shooting stars that have been consumed by friction with the earth's atmosphere, which they enter at a speed varying from ten to forty miles a second.

Astronomers quite frequently observe meteoric particles invisible to the naked eye, flitting across the field of the telescope.



Showing Where the Orbits of Several Thousand Asteroids (Planetoids) Are Located. Their Orbits Take in the Intermediate Space Between That of Jupiter and Mars. These Little Planets Vary in Size from Three Miles to 485 Miles in Diameter. There Are Undoubtedly a Great Many Thousands Also of Even Smaller Diameter or as Small as an Ordinary House.

Some of the larger of these masses weigh several pounds, in rarer instances even several hundred pounds. They are thus referred to as meteorites or fire-balls. These are not entirely consumed by friction with the earth's atmosphere, but after traveling with loud reports and explosions a distance of many miles, fall to the earth's surface.

Comets, it is generally believed, disintegrate gradually into swarms of meteors and the earth and other planets are constantly encountering these fragmentary particles in their journeys around the sun. Periodic swarms are encountered at certain definite times of the year whenever the earth's path crosses the paths of these disintegrated comets.

The study of the origin and nature of meteors forms a most interesting branch of astronomy to which even the amateur astronomer may contribute observations of value.

Questions and Answers.

1. *How many stars are there in the sky and how do astronomers know the number of the stars?*

The approximate number of stars of each magnitude has been found by counting the number of stars in regions of a certain definite size and then estimating from the result the number of stars of each magnitude in the whole sky.

In speaking of "magnitude" of a star, its apparent brightness and not its true or intrinsic brightness is meant. A star of the first magnitude is, according to the scale adopted, two and one-half times brighter than a star of the next fainter magnitude, the second magnitude, and one hundred times brighter than a star of the sixth magnitude, which is the faintest star visible without a telescope. The exact ratio of one magnitude to the next lower is the fifth root of one hundred, so that a drop of five magnitudes represents a division of the brightness by one hundred. A sixth magnitude star has only one hundredth the brightness of a first magnitude star and an eleventh magnitude star only one hundredth the brightness of a sixth magnitude star or one ten-thousandth the brightness of a first magnitude star.

There are in the whole sky only five thousand stars visible without the aid of a telescope; that is, five thousand stars of the sixth magnitude or brighter. Since only one-half of the sky is visible at any one point and since faint stars near the horizon are invisible on account of the greater density of the earth's atmosphere in this direction, there are only about two thousand stars to be seen at any one point on a clear, cloudless night, though one receives the impression that an infinite number of stars exists.

A small three-inch telescope will show stars down to the ninth magnitude and there are two hundred thousand stars brighter than the ninth magnitude.

Fainter stars are far more numerous and it has been estimated that there are approximately *fifty-five million stars* in the first seventeen magnitudes.

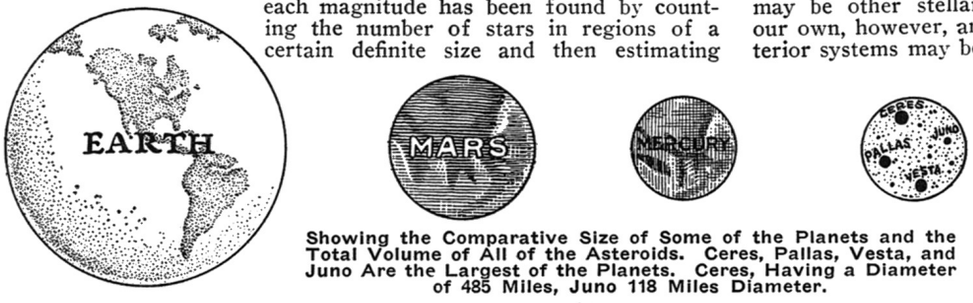
The forty-inch Yerkes refractor will show stars of the seventeenth apparent magnitude and the great one hundred inch Mt. Wilson reflector stars of the twentieth magnitude. This represents the limit of telescope power at the present time, and it is doubtful if it ever can be greatly surpast.

It has been estimated on the basis of counts of stars in sample regions that there are three hundred million stars in the sky within reach of the great reflector.

It is assumed that there is a definite limit to the number of stars within our own sidereal system, for it is evident from actual star counts that the ratio of the number of stars of one magnitude to the number of stars of the next fainter magnitude falls off rapidly for the fainter stars. By the time the seventeenth magnitude is reached a falling off of fifty per cent. in the ratio is reached, which is an indication that the total number of stars is approaching a finite limit provided, as is generally assumed, there is no marked extinction of light in space. It is conceivable that there may be other stellar systems far beyond our own, however, and light from such exterior systems may be in some manner shut off from our own. Nothing is known either to prove or disprove this belief.

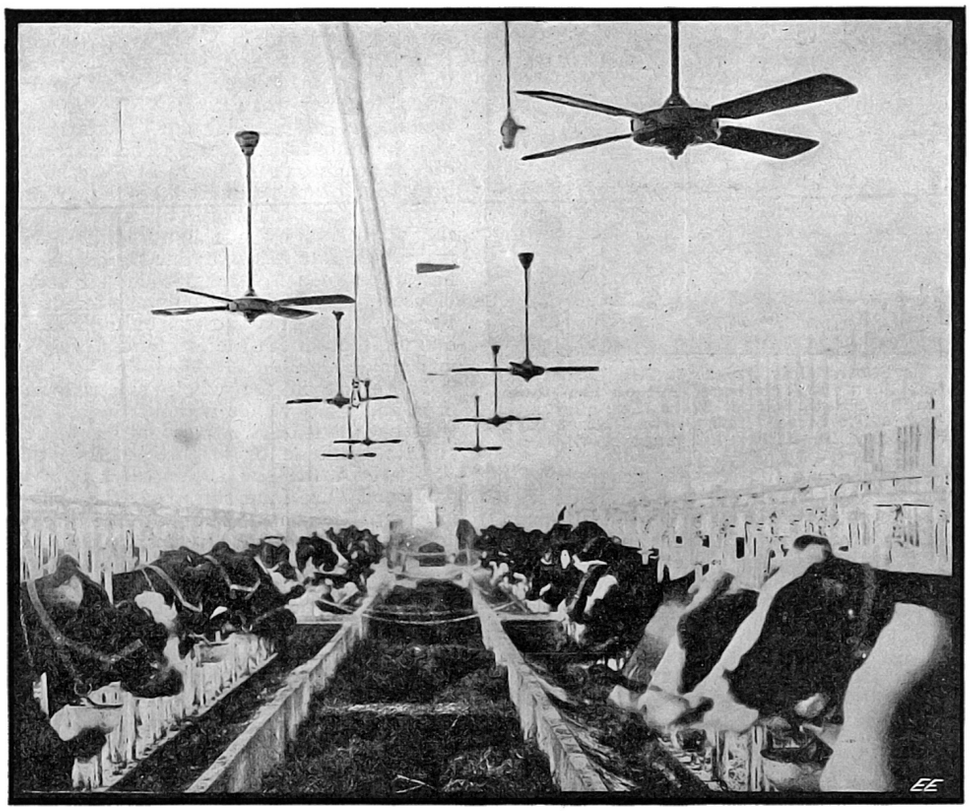
Some astronomers have devised formulas based on star counts to ap-

(*Continued on page* 258)



Showing the Comparative Size of Some of the Planets and the Total Volume of All of the Asteroids. Ceres, Pallas, Vesta, and Juno Are the Largest of the Planets. Ceres, Having a Diameter of 485 Miles, Juno 118 Miles Diameter.

Electric Fans for Madame Holstein



Madame Holstein in Her Glory—180 of Her Enjoying the Cool Breezes from the Electric Ceiling Fans as Installed in a Large Southern Dairy. As Abie Kabibble Would Say—"Some People's Cow-Barns Are Better Than My Parlor, Ain't It?—the Wery Idee."

The cow is distinctly a feminist. Pigs aren't: they don't care. But Madame Holstein is as exacting in her tastes as the most pampered female of the species. Doesn't it strike one as a little ultra-fashionable for 180 cows to drink out of individual fountains while electric fans waft the cool breeze over their aristocratic backs? Mr. Asa D. Chandler, Jr., of Atlanta, Georgia, doesn't think so. He says that his cattle show the results, and he proves it by referring to "Lizzie," who since her entrance into the lap of luxury produces 44 quarts of milk daily.

The barn is provided with concrete floors, wooden blocks, *electric lights, fans* and milking machines, steel frame stalls, novel drinking fountains, concrete feed troughs, electric equipment for the silo and bottling the milk. The Farm has a colony of 180 full-blooded registered Holstein cattle.

Electric *Ceiling Fans* are shown cooling the atmosphere in summer and ventilating in winter. The electric lights are also shown. "Lizzie" has a private drinking fountain. There is always a small amount of water in the bottom of the cement cup to entice her. When she makes the attempt unconsciously, she forces the valve open and hence always has fresh water.

The green corn for ensilage is cut with the aid of a 15-H.P. electric motor, and is blown thru a conveyor into the top of a 40-foot Silo.

Just as soon as the milk arrives at the milk house, it is strained and past over a cooler until it reaches the proper temperature. From here it passes to a bottle filling machine, where the bottle is automatically filled and sealed. (Photo courtesy Westinghouse E. & M. Co.)

Instructor Telephone Boards for Students

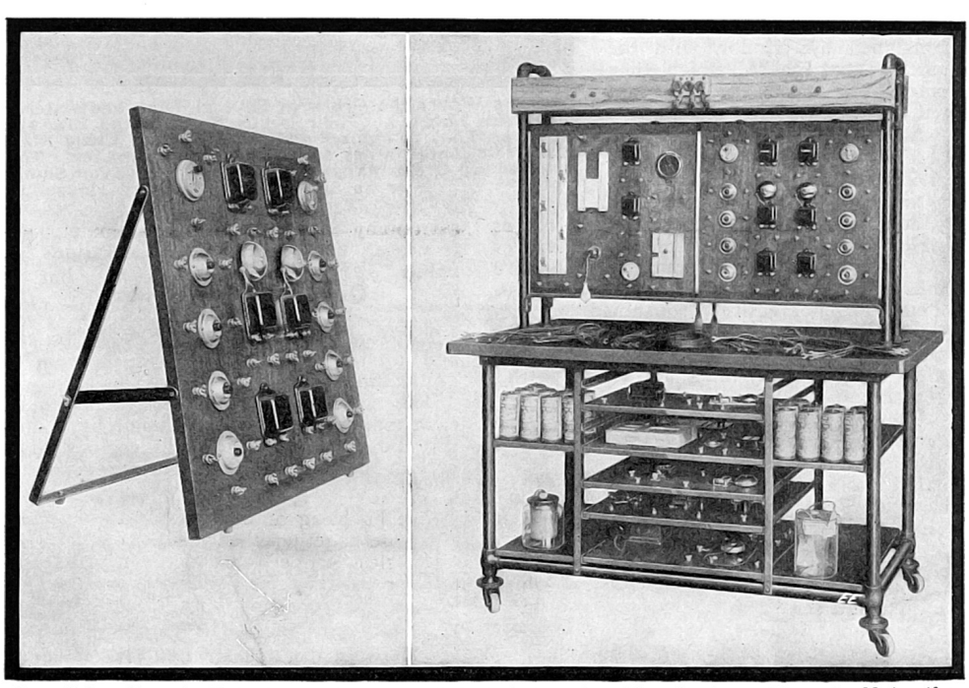
There has long been a demand on the part of high school physics instructors the country over, for a practical method whereby the principles of *telephony and telephone wiring* may be taught in the High School courses. Hitherto it has been extremely difficult to secure proper apparatus, sufficiently durable for laboratory purposes, and inconvenience and expense of installing the necessary instruments for successful instruction in telephony has been very often the cause of the absence of this important branch of instruction in many schools.

To overcome the objections to the old method, and furnish a substantial, practical set of telephone apparatus for the laboratory, the telephone board here illustrated has been designed.

One of the most important features from a practical standpoint of the telephone units is the method by which the contacts are made for interior wiring of the instruments, Ordinarily in laboratory instruments of this character the wiring must be attached directly to the delicately constructed terminals of the apparatus itself, and naturally thru the wear and tear of laboratory usage they quickly become worn out and broken. By the "Instructor" method, these connections are made, not to the instruments themselves, but to substantial wing-nut terminals, which are in turn permanently wired to the proper terminals on the instruments. In this way the life of the apparatus is indefinitely prolonged, as well as much time and effort saved by the making of quick, efficient connections.

There are two types of the bracket form of intercommunicating telephone boards. The single form of board, size 24" x 24", contains two sets of instruments for experiments in intercommunication, while the other type has four telephone sets, permitting the wiring of two, three, or four intercommunicating systems on the same unit. The frame of this latter unit varies from the single bracket board in that it is constructed so as to contain four separate unit boards 9" x 24" in size.

In connection with both of the bracket units there has been designed a *portable table,* substantially constructed with an iron pipe frame, and a heavy, stained table top.



Something New in Telephone "Instructor" Switch-boards. The Students Have to Make the Proper Connections on the Face of the Boards. The Best Idea for Schools That Has Been Brought Out in Some Time.

"The Kaiser is Canned—Can Food"

By GRACE T. HADLEY

SOCIETY FOR ELECTRICAL DEVELOPMENT.

TO save vegetables and fruits by canning this year is a patriotic duty. War has made the need for food conservation more imperative than at any time in history. America is largely responsible for the food supply of Europe. The American family can do nothing more helpful in this emergency than to can all food that can be canned. In this way, the abundance of the summer may be made to supply the needs of the winter.

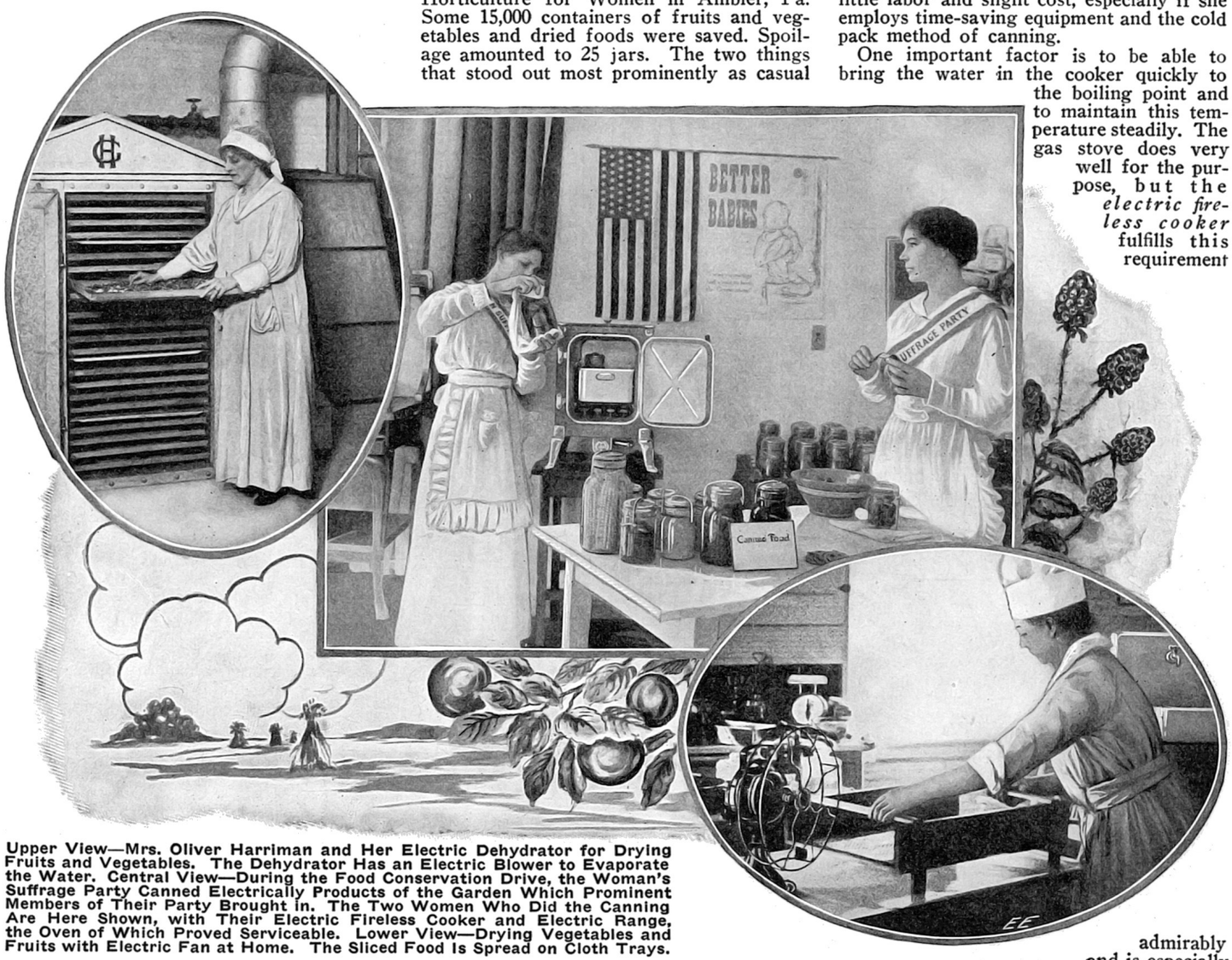
The preservation of food stuffs by canning is always food thrift. It effects the saving of a surplus of foodstuffs that would otherwise be wasted, thru excess of supply over immediate consumption. It eliminates the cold storage cost that must be added to the prices of commodities bought during the winter. Of vital importance also, is the fact that it relieves the strain on transportation facilities of the country.

The president of the *National War Garden Commission* tells us in the *Home Canning Manual* that victory must necessarily bring a large increase in our obligation. We must not only produce food as close to the kitchen door as possible, but we must *save* a vast volume of this food for winter use. To save it, we must can it, dry it, or otherwise prepare to have it in readiness for the winter months. Canning and drying, therefore, are as imperative today as if the great world war were just beginning. A country whose people "can" will never be found wanting.

The Demonstration Kitchen in Ambler, Pa.

During the food conservation drive several hundred women worked in the demonstration kitchen at the School of Horticulture for Women in Ambler, Pa. Some 15,000 containers of fruits and vegetables and dried foods were saved. Spoilage amounted to 25 jars. The two things that stood out most prominently as casual factors were poor rubbers and the development of flat sour.

"In spite of quick and scientific work," Caroline G. Peeler states, *"flat sour* gave us some trouble. We looked for the cause at the beginning of the work and followed it right thru the processing but never thought of looking for it at the time when the jars were sitting happily on the table cooling off. In reply to an 'S. O. S.' call, Washington told us to cool those jars quickly and to do this by placing them one foot apart, so that the air could circulate thru and around them. They must not be in a draft, but the temperature must be reduced rapidly. The jars when first removed from the sterilizer can be seen to be bubbling or boiling. If they are placed close together the heat is confined as in a fireless cooker, causing them to keep warm for hours, chemical changes take place and *flat sour* develops."



Upper View—Mrs. Oliver Harriman and Her Electric Dehydrator for Drying Fruits and Vegetables. The Dehydrator Has an Electric Blower to Evaporate the Water. Central View—During the Food Conservation Drive, the Woman's Suffrage Party Canned Electrically Products of the Garden Which Prominent Members of Their Party Brought in. The Two Women Who Did the Canning Are Here Shown, with Their Electric Fireless Cooker and Electric Range, the Oven of Which Proved Serviceable. Lower View—Drying Vegetables and Fruits with Electric Fan at Home. The Sliced Food Is Spread on Cloth Trays.

Lamp Socket Canning.

Whether one has a sixteen-acre farm or one of the three sizes of commuter's garden, one is sure to have some surplus products and such products should be either dried or canned. "Can surplus food, but use jars and cans wisely," was the verdict last season in order to save every ounce of available food. The thrifty housewife who heeds the foregoing will find that she has quite a store for winter use, with little labor and slight cost, especially if she employs time-saving equipment and the cold pack method of canning.

One important factor is to be able to bring the water in the cooker quickly to the boiling point and to maintain this temperature steadily. The gas stove does very well for the purpose, but the *electric fireless cooker* fulfills this requirement admirably and is especially well suited to take care of surplus products from a commuter's garden. All thru the season odd lots of vegetables that might otherwise go to waste, may be gathered, canned by the cold pack method and sterilized in an electric fireless cooker which is a lamp socket appliance, easy to operate and a great time-saver.

In New York City during the food conservation drive, the Woman's Suffrage Party canned electrically at one of the headquarters stations. Prominent suffragists brought in the products of their gardens which were canned by two women volunteers and the canned products were then sold for the cause of suffrage. Electric fireless cookers were used for the processing as well as the oven of an electric range.

Home Canning Manual.

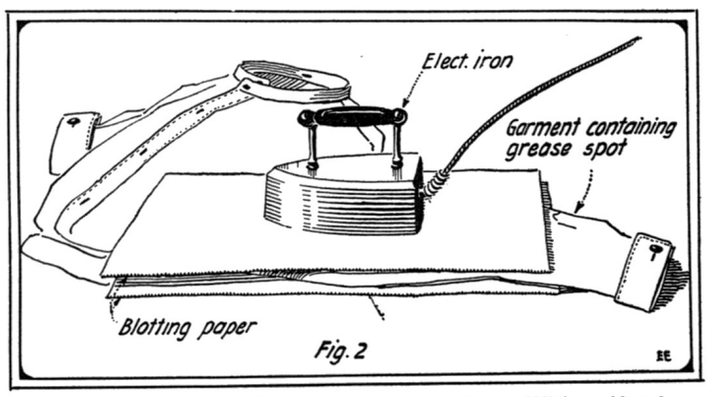
The *Home Canning Manual* issued by the National War Garden Commission of Washington should be in the hands of every woman who contemplates canning. It contains all the necessary instructions for canning vegetables and fruits, the princi-

(*Continued on page* 277)

Practical Chemical Experiments

By ALBERT W. WILSDON

Cleansing and Washing Agents



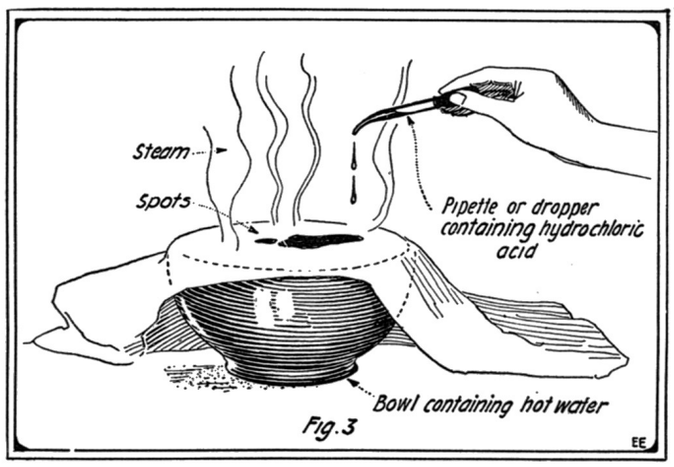


Fig. 2. Left—Method of Removing Grease Spots With a Hot Iron (Electric Iron Very Adaptable) and Two Sheets of Blotting Paper. Fig. 3. Right—Removing Iron Rust Spots. Place the Soiled Cloth Over a Bowl of Steaming Hot Water. Drop Hydrochloric Acid on the Spots and They Will Come Out.

IT is quite likely that practically every reader has at some time encountered the problem of removing some stain or cleaning some substance, and due to the lack of chemical knowledge of the principles of cleaning, has failed in his object. This subject has such frequent applications that it was deemed of sufficient importance to warrant its presentation in this form. Formulas have been omitted, but if desired information regarding them will be furnished by the writer.

Substances used for cleaning may act either mechanically or chemically to remove the dirt or other substances from clothing. In the use of soap and sand for scouring, there is a combination of these methods, and in fact, when the chemical loosens up the fibers or sets free the dirt, some mechanical process, as the washboard or washing machine, preferably electrically driven as shown in Fig. 1, is required to remove it.

Most of the polishing and cleaning powders on the market depend for their efficiency upon the action of a very finely divided substance like Silica, precipitated chalk, or rouge. These are mixed with some fat or oil. In selecting a polishing material, care should be exercised in selecting one that is so finely divided that it will not *scratch* the metal. Dry sodium Bicarbonat (Baking Soda) can be safely used for cleaning and polishing.

Borax, added to water, greatly aids in the removal of dirt. Most readers are familiar with the household Ammonia, which is used for this purpose. As ammonia forms a soap with the oily matters of the fabrics washed, it is a convenient cleaning agent. A teaspoon of Ammonia to a quart of water is an excellent wash for wood-work, and may be used to brighten carpets or rugs. Much of the household ammonia on the market is of a very low grade, and so it is always advisable to purchase it from a supply house, or if necessary from the druggist.

A cleaning material should not only remove the grease or dirt, but it must be of such a nature that the article cleaned will not suffer injury by its application.

Cleansing Leather and Metals.

In some cases, as with wood, leather, metals, etc., the dirt does not penetrate into the interior, but remains on the surface. In other cases the whole fabric is filled with dust and grease. All polished wood surfaces, except those finished with wax, may be cleaned with a weak solution of Ammonia, or soap, but they should never be treated with a strong alkali solution.

As solvents for grease, either kerosene or turpentine may be used, and ordinarily should be applied with a soft cloth. Painted surfaces, especially in white, may be cleaned with a little whiting (Calcium Carbonat), which may be applied with a piece of cheesecloth. The wood is afterwards washed with water and wiped dry. Painted walls, if painted with oil paints can be cleaned in the same way, but tinted walls, since water colors are used, would be disfigured by this treatment.

Leather may be kept bright and clean by the use of kerosene, or occasionally a little oil. Marble may be scoured with sandsoap, and finally polished with a coarse flannel. It should not be forgotten that marble is Calcium Carbonat, and therefore should never be treated with an acid. Metals can usually be cleaned with a hot alkaline solution or a little kerosene. To clean glass, it may be covered with a paste of whiting, ammonia, and water, and after this is dried this may be rubbed off with a woolen cloth or with paper. Alcohol is used extensively for cleaning delicate glass, as for instance, lenses and microscope objectives. In using alcohol for lenses, great care must be exercised, as the mounting paste or adhesive may be dissolved. In extremely cold weather, when water would freeze, kerosene may be used.

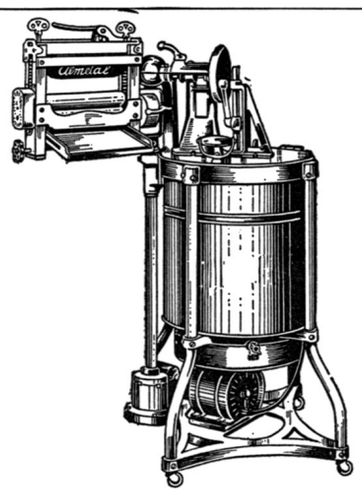


Fig. 1. The Modern Way to Cleanse Clothes Is by Means of the Electric Washing Machine. Many of These Devices Possess Distinctive Improvements Which Make Them Much Superior to Hand Methods.

Dangerous Cleaning Solutions.

Household fabrics are often washed with alkaline solutions or with soap. In some cases Naptha may be used for washing such fabrics. It is to be remembered that in some of the solvents, as Naptha, Benzine, Turpentine, and Gasoline, which are frequently used for cleaning, these vapors are all very volatile, and for this reason *they are dangerous, if employed near a FLAME of any character. These vapors may take fire from a lamp, gas jet, or stove, even at some distance.* Thus it is advisable to do work of this character out of doors if possible. Not infrequently have very serious disasters occurred through failure of the operators to familiarize themselves with the combustibility of the cleansing agents which they employ. Carbon Tetrachlorid is used widely as a scouring and cleansing agent as a substitute for gasoline. Owing to the lack of Hydrogen in its composition, it has the great advantage over the substances mentioned above, of being non-inflammable. In the use of volatile solvents, like gasoline, enough should be used to cover a large portion of the goods, and if possible afterwards washed thoroly with water.

Grease Spots.

To remove stains, spots, and tarnish, the knowledge of a limited chemistry will serve an excellent purpose. As grease is readily absorbed by blotting paper, spots may often be removed from fabrics by placing the goods between two pieces of blotting paper, and then heating with a warm iron, see Fig. 2. French chalk will sometimes absorb the grease, especially if the spots are fresh. Grease may also be removed by the use of hot water and soap, ammonia, or even borax. If there is no danger that these solvents will injure the goods or the colors, it is better to use some solvent such as Chloroform, Ether, Alcohol, Turpentine, Benzine or Naptha. Ether and Chloroform are better adapted to the more delicate fabrics. The troublesome dust spot has usually a neglected grease spot for its foundation. After the grease is dissolved the dust must be cleaned out by rinsing thoroly with fresh liquid or by brushing after the spot is dried.

Removing Paint Spots.

Paints consist of *oil* and *some coloring matter* and *lead or zinc oxids,* thus paint spots should be treated with a solvent for the oil, and then the coloring matter can be brushed off. Fresh spots may be treated

(*Continued on page* 251)

How Big Are Atoms and Electrons?

By L. R. JEWETT

THE study of electrons has recently led to great improvements in apparatus for producing and detecting currents of radio frequency. Doubtless many wireless enthusiasts read about the electron and its behavior in the operation of the electron relay (Audion) but do not know of the characteristics of the electron. The writer will endeavor to set forth some interesting, yet elementary, facts in reference to its characteristics, according to the modern theory of matter.

All bodies are complex structures composed of small particles called atoms and still smaller particles known as electrons. Molecules are groups of atoms and a molecule is the smallest part of a substance which can exist and still retain its chemical properties. For instance, two atoms of hydrogen and one atom of oxygen compose one molecule of water, namely, H^2O. Electrons may be contained in the molecules or free in space between the molecules. None of the particles can be detected by a microscope and the smallest visible particle so far detected with the ultra-microscope is about *twenty-five times the diameter of one of the largest molecules.*

An *atom* is about *one three-hundred-millionth of an inch in diameter.* If the earth were composed of baseballs, it would be an approximate model to a drop of water composed of atoms. In size the *electron* is very much smaller than the atom and it is believed to have a diameter of about *one one-hundred-thousandth that of an atom;* i.e., 1/100,000 of 1/300,000,000 inch, or 1/30,000,000,000,000 inch, diameter of an electron (or there would be 30 trillion electrons to the inch). Thus, if a large building 200 feet square and 350 feet high represented a comparative size of an atom, *an electron would be about the size of the head of an ordinary pin.* Thus the reader may be able to realize the size of the electrons whose performance is so important in many electrical phenomena.

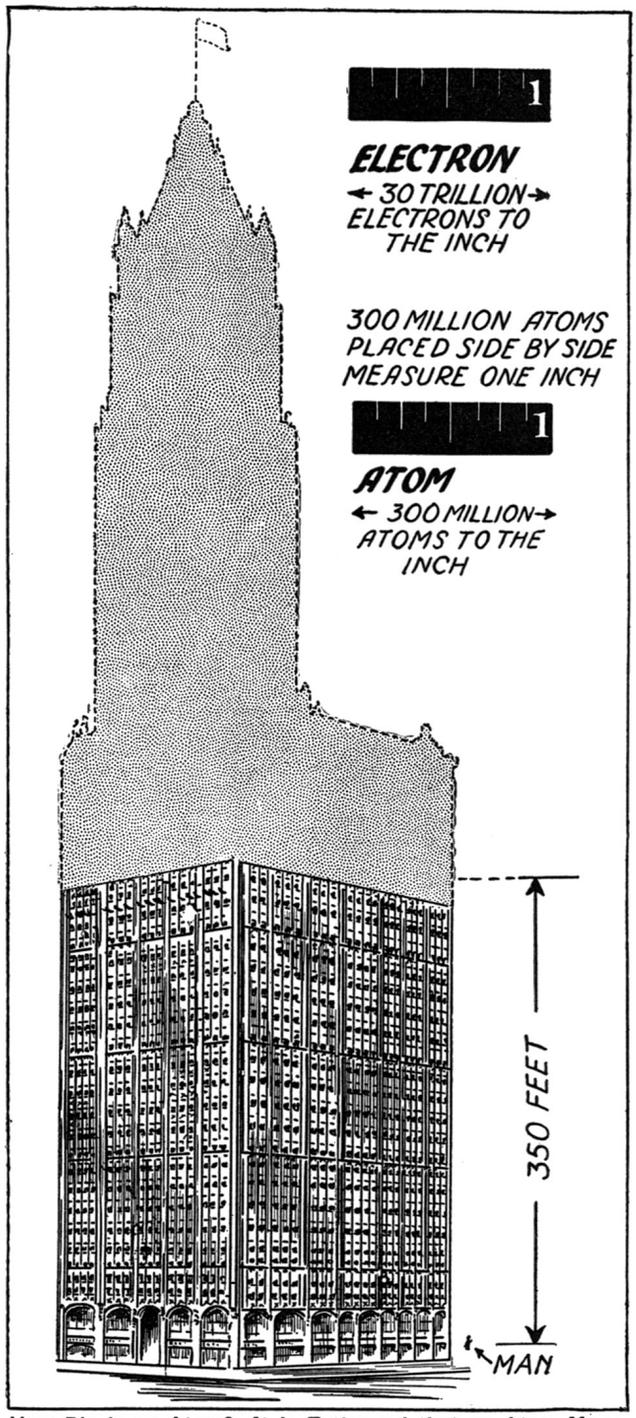
The assumption upon which the electron theory is based is that in every substance, whether charged or uncharged electrically, there exists both positive and negative electricity, distributed on discrete particles. All bodies appear to have large quantities of both positive and negative electricity, usually in equal amounts; thus one charge neutralizes the other and consequently no electricity seems to be present.

The smallest negatively charged particle which can exist in nature and which it is possible to detect is called an electron. Its charge, which is always negative, is less than one billionth of a billionth of a coulomb.

Experiments indicate that the electron is spherical in shape, altho it has not been proven. Its mass is generally regarded now by physicists to be entirely electromagnetic; i.e., it contains a negative charge only and *does not consist of a material substance.*

Electrons are attracted towards all positive charges and repel each other, since they are all of the same charge. There is an attraction between an atom and an electron, but it varies according to the characteristics of the atoms. Attraction between atoms and electrons in non-metals is weak, whereas in metals it is comparatively strong. Thus an electron could move about in a metal with comparative ease. If a stream of electrons is caused to move thru a metal, an electric current results. Therefore, an electric current thru a metal is said to be a stream of electrons moving thru relatively large spaces between the atoms or thru the atoms themselves. The actual speed of the electrons is exceedingly slow, but the rate of transmission of motion from one electron to another electron is very great. This impulse travels one hundred and eighty-six thousand miles per second, but *the electrons themselves may move only a few inches a minute.*

Interesting Facts About the Electron



How Big is an Atom? It is Estimated that an Atom Measures One Three-hundred-millionth of an Inch in Diameter. There Are 30 Trillion Electrons to One Inch. If a Building 200 Ft. Square and 350 Ft. High Represented the Comparative Size of an Atom, an Electron Would be About the Size of the Head of an Ordinary Pin. See Comparative Size Man Holding Pin in Illustration.

Hertzian waves are always produced by causing a charge of electricity to oscillate back and forth, and according to the modern wave theory when this electronic charge vibrates to and fro it radiates electrical waves which go out in all directions in space.

If a metal which contains large numbers of electrons is heated hot, some of the electrons would be given off into space. This is true when the filament of an electron relay or audion tube is heated. Since the plate is positively charged the electrons are attracted to it. Further discussion of the theory of the action of the electron relay or tube will be found in previous issues of this magazine. It is possible to calculate the magnitude of the electron flow from a hot filament.

$$I_B = A T^{\frac{1}{2}} e^{-\frac{b}{T}}$$

Where I_B = Electron current in milli-amperes per CM^2 of filament surface,

T = absolute temperature
$A = 2.5 \times 10^{10}$
B = 52500

A and B are true for a tungsten filament.

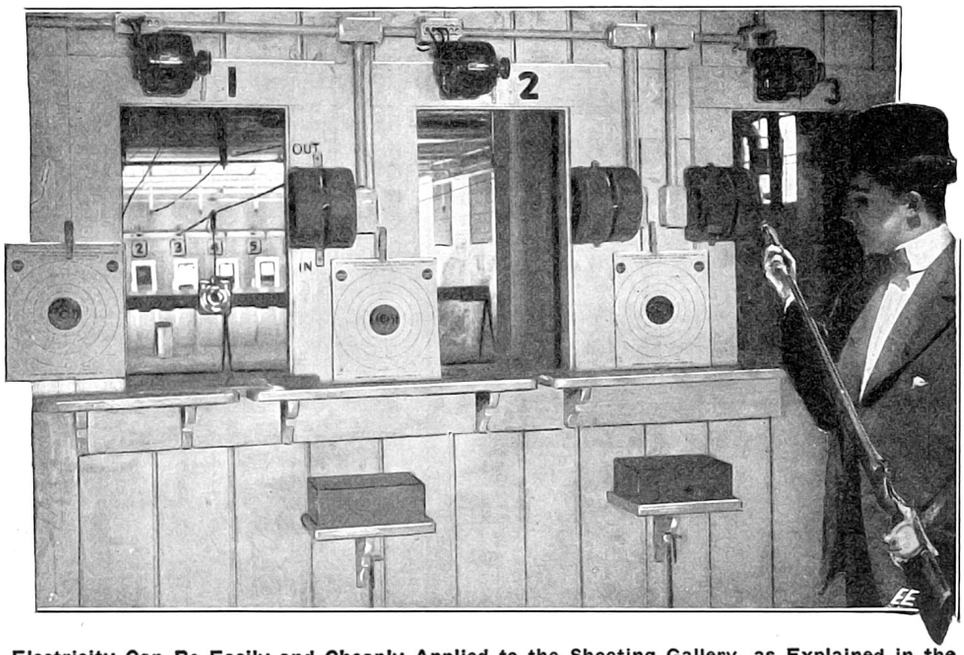
There is sometimes a misunderstanding concerning the difference between an electron and an ion. An electron has been defined as an "electromagnetic mass" having a negative charge. An ion is a material mass having a negative or positive charge as signified. Thus, if a tube containing a heated filament is purely a vacuum tube containing no air, it is a purely electronic emission and no ions are present. This is true of the so-called pliotron and dynatron, the Coolidge X-Ray tube, etc. But if a gas of any sort, for example, ordinary air or pure nitrogen is present in any degree in the tube, ions will be present also since the gas is "ionized" by the collision of the electrons and the atoms.

The modern electron theory is playing a very important part in the theory of the performance of different wireless instruments and systems. The above facts will no doubt tend to give the amateur a general idea of what an electron is and its behavior.

Those interested in the study of the electron theory will do well to look up some of the highly interesting articles publisht in back numbers of this journal, as well as such works as Professor Millikan's excellent treatise, "The Electron"; "Conduction of Electricity Thru Gases," by Thomson, and "Nature of Matter and Electricity," by Comstock and Troland. Articles in past issues of this journal: "Cosmic Force," by L. M. Correll, April, 1918; "Can Electricity Destroy Gravitation?" by Nipher, March, 1918; "Modern Physics and the Electron," by Prof. R. A. Millikan, January, 1918; "Does Radiant Light Possess Weight?" by A. R. MacPherson, July, 1917, issue.

THE CONSTRUCTOR

An Electric Shooting Gallery



Electricity Can Be Easily and Cheaply Applied to the Shooting Gallery, as Explained in the Accompanying Article. The Targets are Carried to and from the Marksman's Position by Motor Operated Cables. The Motors are Reversed by a Simple Switch. The Motors May Be Ordinary 1/15 H.P. Fan Motors. You Can Thus Check Your Own Targets.

IN the ordinary shooting gallery or rifle range it is invariably necessary for someone to replace the targets and also to keep the score where continuous shooting is carried on. Therefore, even with the individual rifle range, it has always been a serious draw-back in that someone had to be employed to change the target and either keep the score in a score book, or else after a given number of rounds to return the target to the marksman. These desideratums have been well taken care of and circumnavigated by a very ingenious electrical scheme which has proven an unqualified success at the rifle range of the Lynn Rifle and Revolver Club, maintained by the employees of the General Electric Co., at Lynn, Mass.

The Lynn Rifle and Revolver Club has about 160 members and the membership is open to all employees who are citizens of the U. S. A. In addition to the Rifle Range, the club has also facilities for pool, billiard, chess, checkers and cards. The whole is installed in the basement of an old office building on Center Street, together with the Bowling Club Alleys.

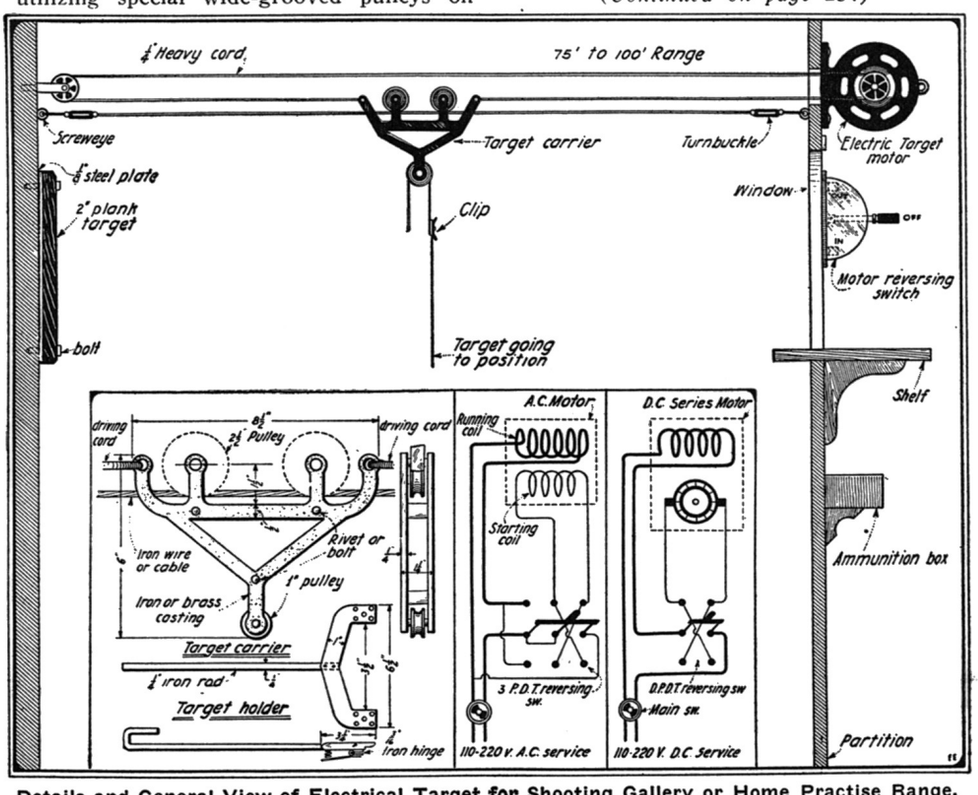
This electric shooting gallery contains eight stations. The present view was taken from the firing station and shows the small electric motors for driving the target carriers which are type 1/15 H.P.-220 volt-60 cycle motors. These are controlled by double-pole double-throw knife switches with a fiber guard which is also shown.

The accompanying diagrams show how the carrier, which may be made of aluminum or cast iron, wrought iron bar, or even of wood, is arranged to travel along the carrier cable. This cable may be made of ¼ inch galvanized steel stock, such as is sold for wash line purposes, and it can be anchored on either end by means of large screw-eyes, thoroly secured in walls or posts, and placing a turnbuckle at one end of the cable so that it can be tightened up as required. The driving cord which pulls the target carried back and forth may be a piece of ¼ inch rope, and by utilizing special wide-grooved pulleys on the motors, the hauling rope can be given a turn or two about the pulley, so as to have a much better frictional contact with it.

Two different ways of starting, stopping and reversing electric motors suitable for controlling the target carrier are shown herewith. Any electrician can hook up these motors, and in fact anyone a little handy in electricity and mechanics can rig up the switching scheme whereby the motors are controlled. The principle of reversing small motors may be stated as follows: For small series-wound D.C. motors, the stationary or field coil terminals must be reversed to change the direction of rotation. However, either field or armature connections may be reversed for shunt-wound D.C. motors, while for the usual type of self-starting single phase A.C. motors, it is necessary in order to reverse the direction of rotation, to reverse the connections of the starting coils, or rather the terminals going to these coils and which lead out to the terminal board of the motor.

The *modus operandi* of this electric shooting gallery is carried out thusly: The marksman turns the main switch and then throws the *reversing switch* to the "in" position, if the target carrier happens to be at the rear of the range. When it approaches the forward end and the range at which it is stationed, the reversing switch is pulled out to the "neutral" position. A new target card is then inserted in the spring clip of the carrier and the old target kept for checking up the score. The reversing switch is then thrown to the "out" position, so that the motor reverses its di-

(*Continued on page* 254)



Details and General View of Electrical Target for Shooting Gallery or Home Practise Range. The Details are Simple. Its Efficacy Is Attested by the Fact that It Is in Use at a Large "Gun and Revolver Club" at Lynn, Mass.

Improved Capillary Battery

By THOMAS REED

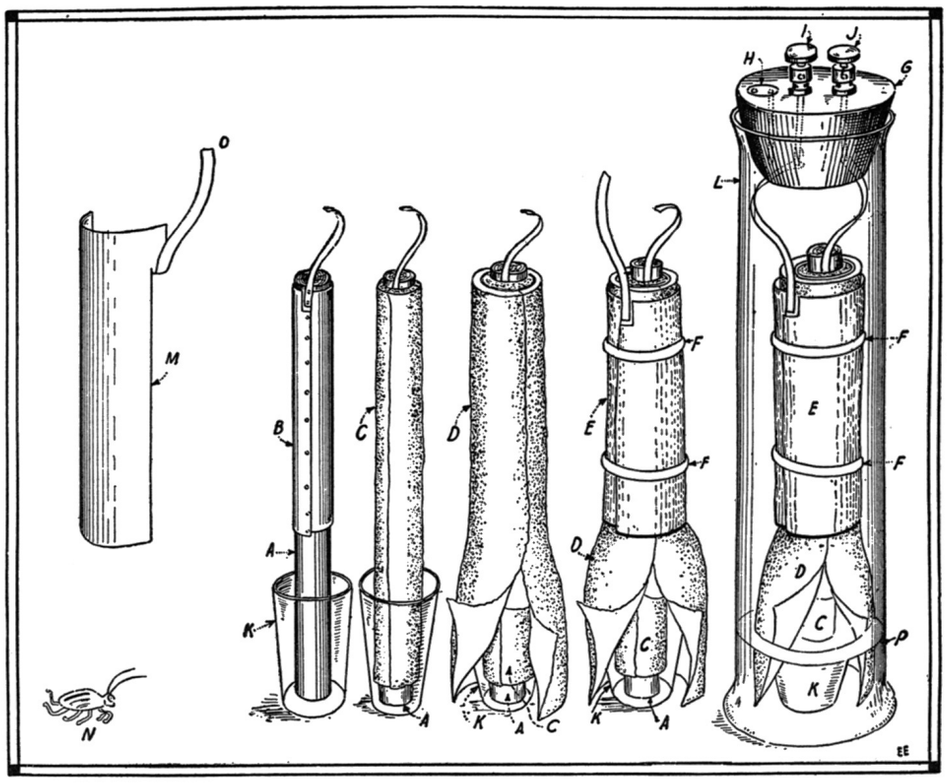
YOU remember my *capillary battery* using two solutions, copper and zinc sulfate, which demonstrated that the solutions wouldn't mix when contained in a capillary mass like burlap, thus giving a battery of very long life on open circuit, or one of small output? The only trouble with *that* battery was its high internal resistance, and I've doped out a startling modification of it with a lower resistance, which may amount to something, provided the solutions still decline to mix under the new arrangement.

I have to postpone trying it out until I get to the "summer place" on the Cape, where my tools are; but as it's so simple perhaps some fellow "Bug" would like to make the experiment now, and beat me to it. I'll say it's worth while, for even if the cell produces but ¾ of a volt, it wouldn't take an unreasonable number of 'em to form a nice "B" battery for Audions, while they'd cost practically nothing, and if they worked at all they'd work for years.

I've drawn the thing in successive stages, to make its construction perfectly clear. You begin with a wooden dowel A, of a length proportioned to the containing bottle you're going to use. Around this you bend the very thin copper sheet B, and tack it on with copper tacks. M shows the manner of preparing this sheet, with a strip O slit nearly to the top and turned up to form a connector. K is a small whiskey-glass (anybody'll give you a whiskey-glass after July 1st) which will contain the sulfate of copper solution.

Next, you wrap the dowel—with its partial copper-coating—in the thick burlap C. I should think one layer would be enough. This goes nearly the full length of the dowel, as it is to extend down into the copper solution and draw it up by *capillarity*. At this point soak C with copper solution, so you won't have to wait for it to soak up later, also to prevent its exhausting the contents of K.

Now for another layer of burlap, D, a little longer this time, as it goes down outside of K, and dips into the sulfate of zinc (or acidulated water) solution. Nothing between these two layers of burlap; each will be saturated with its own solution and they're supposed not to mix on account of the capillary action. I have folded D back to show the interior, but the flaps will be let fall in practise. Soak D in acidulated water before putting on.



Successive Stages in Building Tom Reed's Improved Capillary Battery. It Gives Approximately Three-quarters of a Volt and Should Prove Useful in Making up "B" Batteries for Audion Circuits.

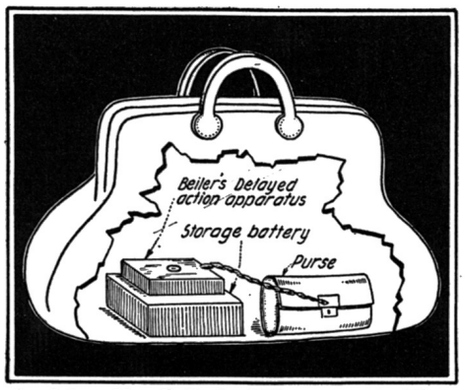
Finally comes E, a sheet of zinc, also prepared with a connecting strip. No soldering necessary, just bent around and held by the two rubber bands F F. 'Tis well to amalgamate the zinc.

Now for the bottle, L, an olive or pickle bottle with a well-fitting cork G. The zinc and copper strips are connected to the binding posts I, J. You'll also want a vent-hole H, covered with a piece of soft rubber, to release the gases without evaporating the liquids. P shows the common level of the liquids both inside and outside the cup K—saturated copper sulfate, with a few crystals added inside, and acidulated water outside.

N represents an industrious "Bug" beating me to it. Hope he doesn't return with news it's no good. We thank you for your kind attention. Refreshments, second door on the left.

That Wonderful Electric Action-Delayer

By THOMAS REED



Applying Mr. Beiler's "Thermostatic Time-Switch" or Action-Delayer to the Shopping Bag. It Opens the Purse Two Minutes After You Decide to Buy Some Worthless Junk—Giving You Time to Change Your Mind!

DID you read that article in the November number by Mr. Albert H. Beiler, describing a "thermostatic time-switch" he'd invented? Lighting a lamp, not just when you push the button, but two minutes afterward? And did you mind what he said—"If you ask me what real use it has. I can't tell you?" S-ay . . . !

If ever there was a Regular inventor—"Regular" with a Capital "R" at the beginning and a Scotch growl at the other end—it's A. H. Beiler. Invents an invention—and such an invention as THAT—and doesn't know what it's good for! Why, Al, for the love of Pete wake up and put your collar on before the cheering crowd gathers at your door! It's an epoch-maker.

There may not be any great object in delaying the action of a light, because you generally want it about the same time that you get around to pushing the button; but if you substitute for the lamp a motive apparatus, think, Man, what you've got—the greatest little second-thoughter in the world! You can have all the effect of a final decision in pushing the button, and yet have two whole minutes in which to change your mind.

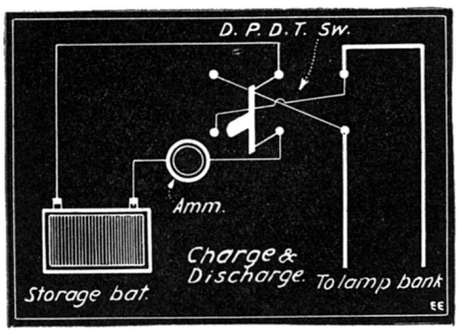
I see where it's going to be applied to every door-lock right away. The Missis hears a ring, and pushes the door-button. Almost immediately she thinks, "What if it's a tramp?" She goes to the window, and sure enough there's a coat-tail sticking out from under the porch. It looks untidy, possibly ragged. Visions of robbery and murder, but—the lock has not yet operated, thanks to the beneficent Beiler. There's time to run back, press another button and cancel the order. As a matter of fact it's not a "burgular" but her brother with a nice

(*Continued on page 277*)

Storage Battery Testing

By Harold R. Adams
STORAGE BATTERY ENGINEER

AN outline of the methods used in commercial storage battery work, adapted to the requirements of the layman and amateur electrician is given in the following paragraphs, which may prove of assistance. The first



Handy Circuit for Charge and Discharge of Storage Battery in Testing Work. An Ammeter Should Always Be in Series With the Battery.

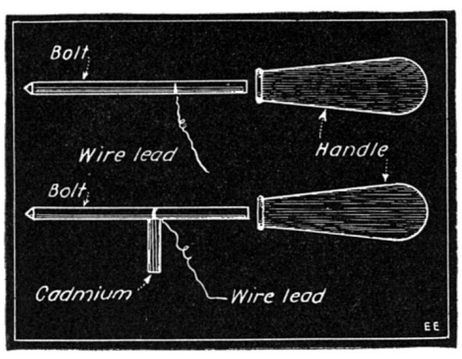
step is to determine the capacity of the battery under test. The capacity in ampere-hours, the charging rate at start and finish, etc., will usually be found on the name-plate of the battery.

When these have been determined the battery should be connected to a source of *direct current* and charged at the finishing rate until the cells gas freely and the E.M.F. (voltage) reads in the neighborhood of 2.5 to 2.6 volts, connected to charging current.

If the battery is of the starting or lighting type the specific gravity should read 1.285 at 70 deg. F. The *gravity* of truck batteries sometimes is a little lower than the above; however, it should be given on the name-plate or in the instruction pamphlet that is sent with the battery.

Before going any farther we will sum up the instruments needed to properly conduct the tests.

1 Hydrometer reading from 1.150 to 1.300
1 Thermometer (floating type)
1 Ammeter
1 Voltmeter (3 volt scale)
1 Lamp bank (where 110 volt direct current is used) or
1 Rheostat (where low voltage generator is available)
2 Iron bolts, 4 inches long, ¼ inch dia.
1 Cadmium rod 3 inches by ¼ inch
12 Feet stranded rubber covered cable, 14 B. & S. gage.



How the Battery Testing Prod and Cadmium Electrode Is Constructed. Brad Awls Make Good Test Prods and Cost About 10 Cents Each.

The heads should be cut from the bolts and the threaded ends inserted in wooden handles shown in figure. The cadmium rod should be soldered to one of the bolts as shown in the same drawing.

The stranded wire should be cut in half and one piece soldered to each *prod,* as shown in the illustration, the other end being connected to the voltmeter. The prod with the cadmium electrode should be connected to the positive terminal of the meter.

A very convenient hook-up is here given for charging and discharging the battery or cells. An ammeter should be in series with the battery all of the time.

When everything is ready the battery should be put on charge at the finishing rate, until the cells gas freely and the voltage reads 2.5 to 2.6 volts per cell, and the gravity of the electrolyte is correct. If the gravity of the electrolyte does not increase to the proper point after a couple of hours charging it will be necessary to add a little strong acid, great care being exercised in doing so and also in making temperature corrections in case the temperature is other than 70 deg.

The following rules governing the cadmium test should be carefully studied before going any farther if the tests are to be a success.

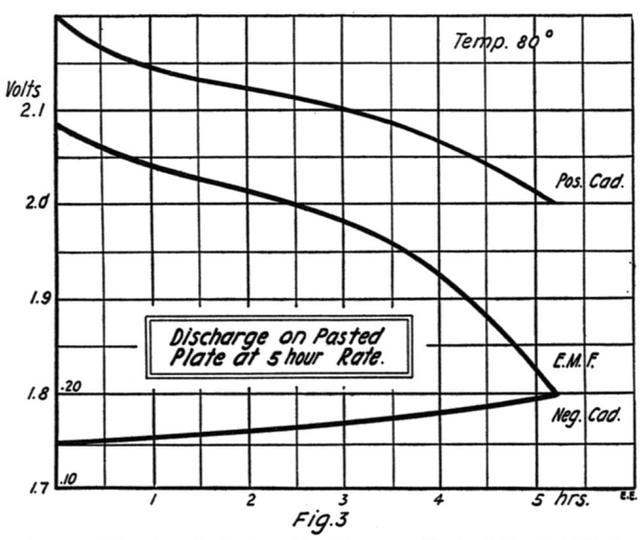


Fig. 3

Curves Showing Cadmium Readings on Test of Pasted Plate Battery at Five-Hour Rate.

The sum of the positive and negative cadmium readings should nearly equal the voltage across the cell when the cell is charging.

The difference between the pos. and neg. cadmium readings should equal the voltage of the cell when on discharge.

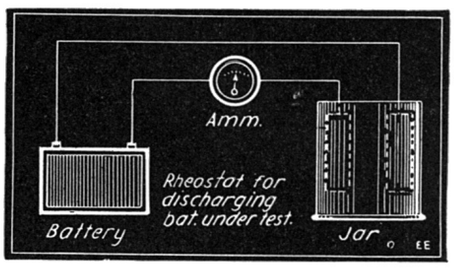
The positive cadmium always reads plus.

When the cell is charging neg., cadmium reads minus.

When the cell is discharging the neg., cadmium reads plus.

To take a cadmium reading immerse the cadmium electrode in the electrolyte and bring the other prod in contact with either the pos. or the neg. pole of the cell according to which cadmium you wish to read. When the cadmium is not in use it should be kept immersed in dilute acid (electrolyte), otherwise the readings will be incorrect.

When the cell is fully charged the E.M.F. across the cell should read from 2.5 to 2.6 volts and the pos. cad. from 2.38 to 2.44 plus. The neg.— cad. should read from —.16 to —.20 when the cell is in good condition. It has once been noticed by the author that a neg. cad. read *plus* on charge. This was found to be due to the fact that the battery had been heavily overcharged.



A Water Rheostat Proves Useful for Absorbing the Energy from Storage Battery on Discharge Test.

The plates were removed and prest, and gave very good service afterwards. The heavy overcharge had filled the pores of the plates with hydrogen which is positive to cadmium.

A slight overcharge of a couple of hours at the finishing rate about every five cycles is good for the battery, but a heavy prolonged overcharge, especially at a high temperature, will result in the ruin of the battery if allowed to occur too often.

When the battery has been fully charged and the readings recorded it should be arranged for discharge.

To discharge a battery at the standard *eight-hour rate* requires quite a little time. However, it has been noticed that when a battery is discharged at a higher rate that the *ampere-hour output is lessened a certain per cent.,* depending on the ratio of the rate of the discharge. Advantage may be taken of this fact and the following table of percentages and the time needed for the test considerably reduced. The figures in this table are taken from experiments made by the author and may be used for any make of lead plate battery, except the Edison, which is an iron-nickel element.

Table 2

Hour Rate	Pasted Plate	Plante Plate	Hour Rate	Pasted Plate	Plante Plate
8.00	100 %	100 %	1.50	53.5%	63%
7.00	96 %	99 %	1.00	46 %	55%
6.00	92 %	96.5%			
5.00	86.5%	93 %			
4.00	80 %	88 %			
3.00	72 %	80 %			
2.00	61 %	70 %			

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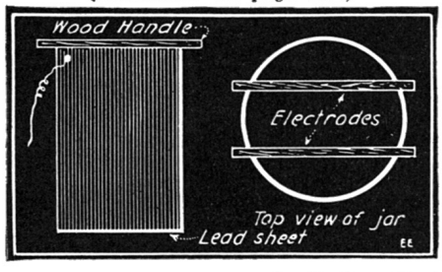


Details of Water Rheostat for Battery Testing. The 2 Electrodes are Made of Lead or Iron, Etc. Solution May Be Salt and Water or Bicarbonate of Soda.

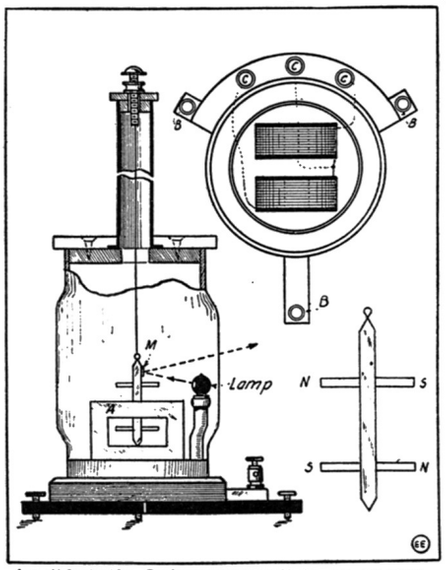
HOW TO BUILD AN ASTATIC GALVANOMETER.

By C. G. Yungblut.

THE great trouble with many "how-to-make-it" articles is that they call for tools or material which the experimenter does not possess, and generally time or pocket-book prevents him from obtaining them. But luckily in electrical construction, if one thing is lacking, another can generally be supplied that will perform the service quite as well, and the experimenter can turn out a creditable piece of work whatever his resources may be. Especially is this true in the constructing of galvanometers.

Suppose, for instance, you want a good sensitive galvanometer, and you want to make it yourself. The *D'Arsonval* type is out of the question, let us say, because you haven't the required magnets. Make an *astatic*, then. The first thing that causes trouble is a covering to protect the delicate suspension from currents of air. A clear glass cover the proper size and shape would cost a good deal. But here's an easy way out of that dilemma. Get one of those glass chimneys used on gas burners, one of the cylindrical kind, that narrows down at both ends. Procure one of good clear glass, free from bubbles and ridges, and you have an excellent cover. The next difficulty is the suspension. To be delicate, it should be high, higher than the cover itself.

Let us make a top for our cover. If you have a lathe turn one from wood or fiber that will just fit into the top of the cover,



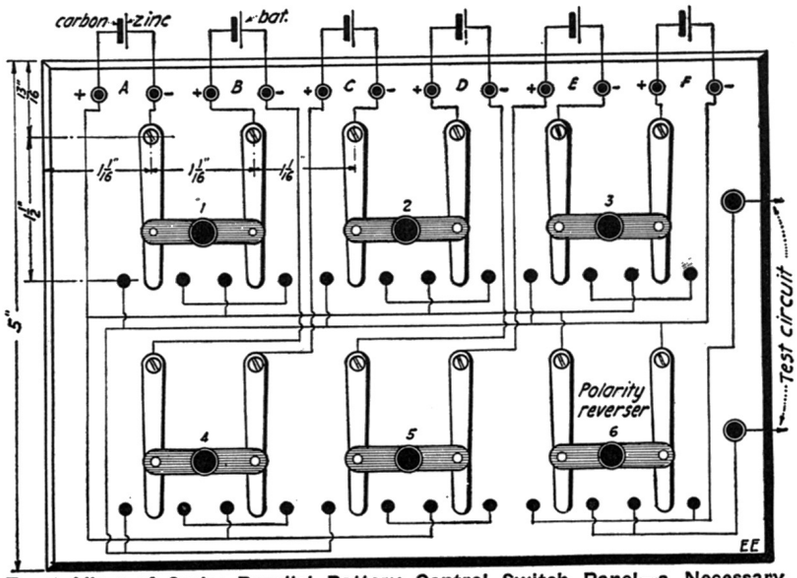
An "Astatic Galvanometer" Is an Instrument Which Every Student Does Not Care to Purchase. Yet He Often Needs It Urgently. The Present Article Tells How to Build a Very Sensitive One of the Reflecting Mirror Type.

with a flange to keep it from slipping thru. If you have no lathe, cut out two disks of thin wood with your pen knife, or a scroll saw, one just large enough to slip into the top of the chimney and the other about three-sixteenths of an inch larger all around. Fasten the two disks together, and you have a cover as good as one turned on a lathe. Next get a large test tube, and cut off the closed end, so that a cylinder of glass with a flange at one end is left. Bore a hole in the center of the cover you have just made, slightly smaller than the internal diameter of the test tube, and fasten the tube in place over this hole. If you have made the cover of two disks, the flange of the test tube can conveniently be placed between the two before you fasten them together, as the diagram suggests. Now assemble the cover and its top with the tube in place.. You can at once see that if the astatic element, M, is hung from the top of the tube, the suspension will be high enough, and will be completely protected.

(*Continued on page* 278)

A Series-Parallel Battery Switch

A very convenient switch for quickly and easily connecting battery cells in a variety of combinations is herewith described. No machine work or intricate designing is necessary. Carefully lay out the location of the holes on the fiber base according to the diagrams. The holes on the under side of the base, which are not shown in the present illustrations, are drilled with a No. 40 drill to a depth of 3/16" with a 4/36 tap; tap one turn enough to get a screw started. Be careful not to go thru the base with the drill or tap. The continuation of these holes in the fiber strips forming the sub-base are drilled with a No. 32 drill, to allow the 4/36 screw to slip thru easily, and slightly countersunk. The size of the holes for the binding posts will depend on the size of the binding post shank. All other holes in the base are drilled with a No. 18 drill. Fasten the sub-base strips to the under side of the base with the No. 4/36 by 7/8" screws; be careful not to strip the threads. File and sandpaper the whole base to give as near as possible the appearance of a solid piece.



Front View of Series-Parallel Battery Control Switch Panel—a Necessary Adjunct to the Experimenter's Laboratory. Any Desired Grouping of the Cells—Series, Parallel or Series-Parallel—Is Possible by Its Use.

The following materials will be needed:

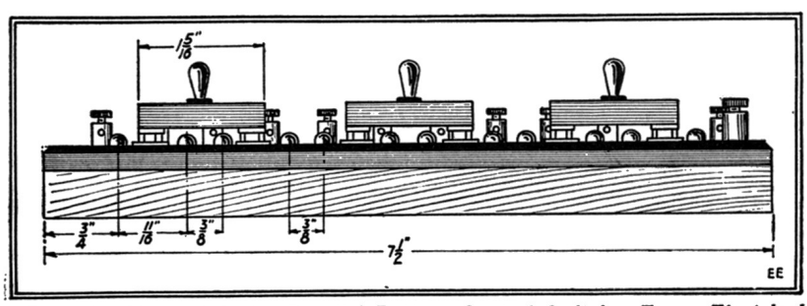
One fiber base, 7½" x 5" x ¼".
Two fiber strips, 7½ x ¾" x ¼".
Two fiber strips, 4½" x ¾" x ¼".
Twelve fiber strips, 1 5/16" x ¼" square.
Twelve copper strips, 1¾" x ¼" x 1/32".
Fourteen small binding posts.
Twenty-four round-head machine screws, 8-32 x ½".
Twelve round-head machine screws, 8-32 x ¾".
Twelve flat-head machine screws, 4-36 x 3/16".
Eight flat-head machine screws, 4-36 x 7/8".
Forty-eight hexagonal 8-32 nuts.
Eighty-four 3/16" dia. washers.

Next, drill a No. 18 hole 3/8" from one end of each of the copper strips; also drill a No. 32 hole 1⅜" from the same end, and countersink. The corresponding holes in the ¼" square by 1 5/16" fiber strips are drilled to a depth of 3/16" with a No. 40 drill; make these holes 1/8" from each end, and tap the turn with 4/36 tap; the screw will then go in very tightly without binding on the copper strip. Fasten these handles on the switch blades first; then put an 8/32x¾" screw thru from the top of each blade and run up a nut on the other side. Then put on a washer and insert in the proper holes in the base, and put on two washers; then fasten with one nut. For the contact-points, put an 8/32x½" screw thru each of the proper holes on the base, put on two washers underneath and then proceed to fasten with one nut.

The connections are made according to the diagram in Fig. 3. Unless all connections are soldered, the wires must be run from one contact to the other, instead of being tapt off as shown. Do not use smaller wire than No. 18 D. C. C. for this purpose. Place all ends of wires between washers, and screw nut up tightly, being careful the switches do not bind. Then coat the wires with heavy shellac or glue to hold them in place.

The cells to be operated are permanently connected to the binding posts marked by the letters "A, B, C, D, E, F" in Fig. 3; connect one cell to each pair of posts; the positive and negative polarities must alternate as indicated. The possible combinations are tabulated in Fig. 4, which should be used for reference. Switch No. 6 is first thrown to the left or right, according to the polarity desired at the test current terminals. When using the switch-board this switch must be thrown either in one position or the other. Under "CELLS" look for combination desired; under "SWITCH POSITION" find position of switches to give the combination. For example: to obtain current from 3 cells in series and 2 in parallel, look in column marked "CELLS" and in "Series" column find 3 and in "Parallel" column find 2. Under "SWITCH POSITION" in columns marked "LEFT" and "RIGHT" find "2" and "1, 3, 4, 5," respectively. Place switch No. 2 on its left-hand contacts and switches Nos. 1, 3, 4 and 5 on their right-hand contacts; the current is taken from the pair of binding posts near the right-hand edge of the base. If the polarity is to be changed, move switch No. 6 to the opposite position. The switches that are not specified in the table for any particular

(*Continued on page* 275)



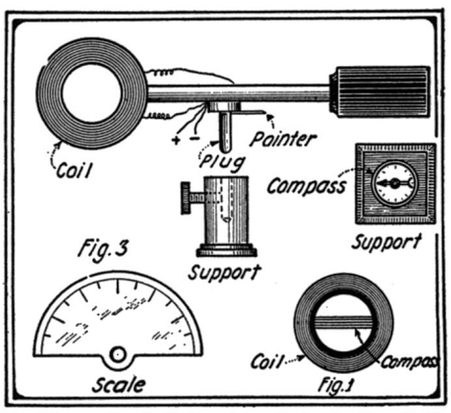
Edgewise View of Series-Parallel Battery Control Switch. Every Electrical "Bug" Will Find This Switch of Great Usefulness in His Laboratory.

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

A Laboratory Measuring Instrument

FIRST PRIZE, $3.00

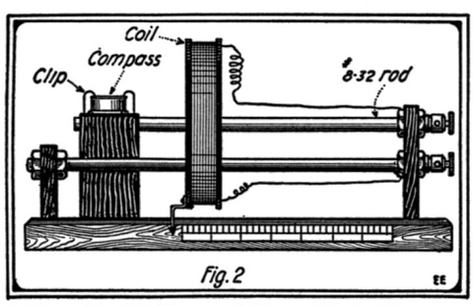


The Magnetic Coil Used to Actuate the Calibrated Compass Is Here Shown Mounted in a Pivoted Pedestal.

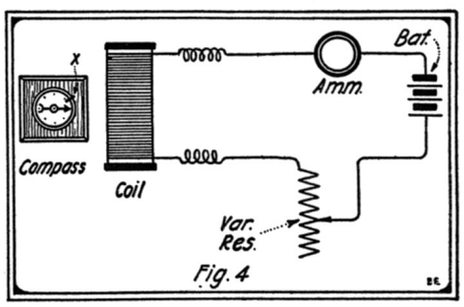
If we take a coil of wire as shown in Fig. 1 and set a compass in the center as shown, with the compass needle pointing in the plane of the coil, then when current is past thru the coil the needle will swing at right angles to the plane of the same. One objection to this type of apparatus is that it is very critical and no direct readings can be taken to scale—for this reason the following instruments if properly constructed will be of advantage to any experimenter in his laboratory. It not only being cheap in construction but it is likewise efficient when calibrated by a method given below.

In Fig. 2 one type of instrument is shown. A compass is clamped on a wooden stand by two brass clips as shown and the coil (current coil) is supported by the 8/32 rods and slides back and forth on them. A pointer is affixt to the coil and moves over the scale.

In Fig. 3 the compass is supported on a wooden stand in the same manner described above, but here the coil rotates away from the compass on a 90 degree angle (or quarter circle) decreasing its distance from the compass in that manner. Here, of course, the scale has to be affixt to the support which also holds the coil, its arm and handle.



A Very Useful Form of Home-Made Measuring Instrument. The Compass Is Affected in Proportion as the Coil Is Moved Toward or Away from It.



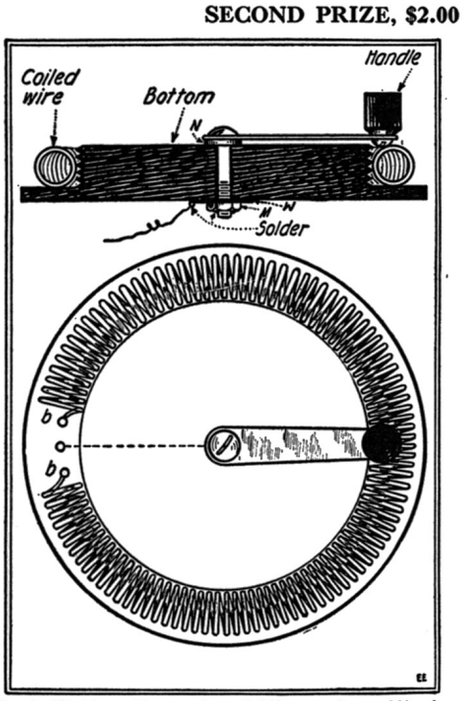
Hook-Up of Apparatus for Calibrating. The Current in the Coil Is Varied by a Rheostat.

Calibration of the Instrument: As shown in Fig. 4 a standard ammeter for battery use is connected in series with the coil and the batteries, the current from the batteries is regulated by a variable resistance. A mark is made with black paint on the compass as shown at X in the drawing. This mark is employed in the following manner: The coil is moved one degree on the scale and the resistance varied until the compass deflects to the mark—this is noted on the scale—and the coil is then moved back another notch on the scale and the same procedure complied with, until finally the entire scale is plotted. This makes a very neat and efficient measuring instrument.

Contributed by E. T. JONES.

A Rheostat Push-Button

SECOND PRIZE, $2.00



Push Button Bases Lend Themselves Nicely to the Construction of Home-Made Spiral Wire Rheostats.

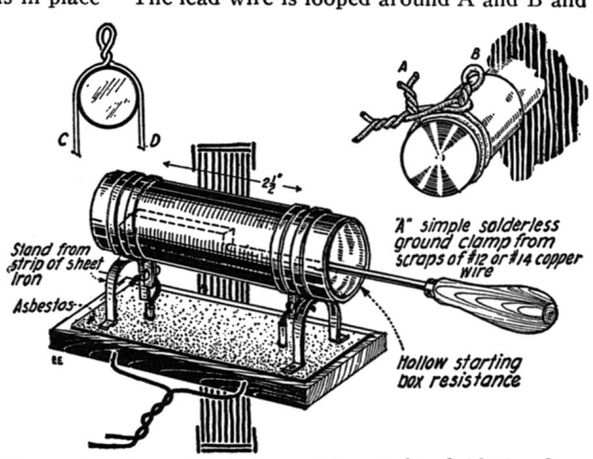
Remove all contacts and other trimmings from the bottom of a common wooden push-button. Then make a coil of resistance (iron, German silver, etc.) wire, put it in position shown, and fasten the ends in place by two binding posts, b and b. The contact arm is sheet brass, 1/16 inch thick. The handle is a piece of one-half inch dowel, fastened by a small round-head wood screw, which makes contact with the wire. The arm is fastened securely to the bolt by a nut, N. A washer, W, is slipt over the bolt on the back at the bottom, and then another nut, M, which is soldered to the bolt. A wire is soldered to the washer for connections. This rheostat should be used for light work only.

Contributed by ROBERT HERTZBERG.

Soldering Iron Heater

THIRD PRIZE, $1.00

sketch explains the stunt sufficiently, except that in putting on the clamp the loop (B) should be made first; then the two ends (c and d) bent around and twisted at (A). The lead wire is looped around A and B and twisted up tight, giving a firm joint.



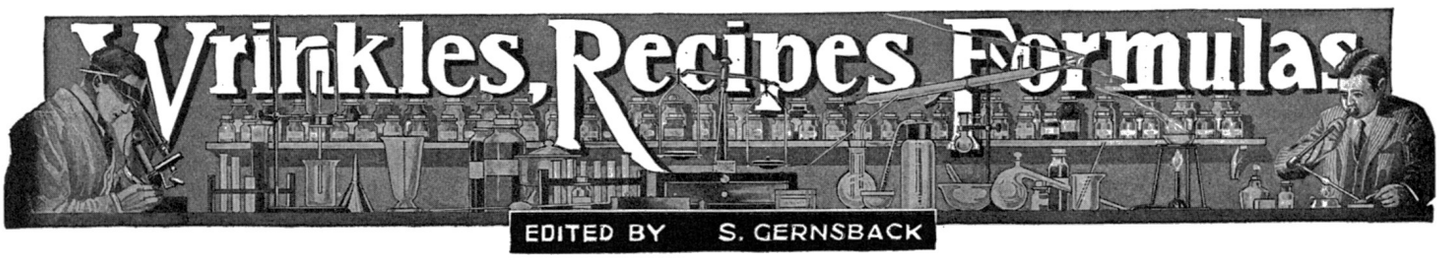
Making a Ground Clamp in a Jiffy—and a Soldering Iron Heater.

The other stunt is a soldering iron heater made from a discarded starting box coil.

Contributed by E. McALLISTER.

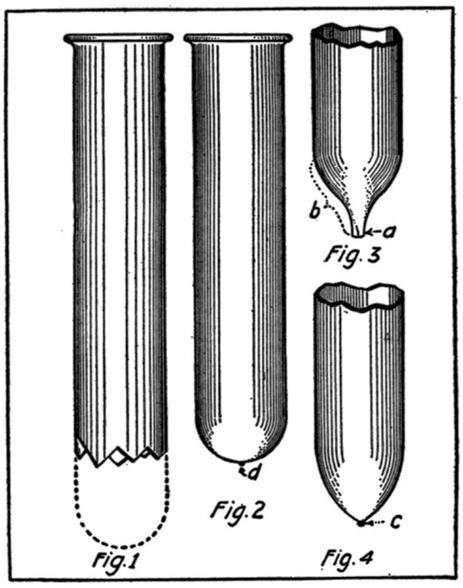
A "TWO SECOND" GROUND CLAMP AND SOLDERING IRON HEATER.

My "two-second" ground clamp is made from scraps of No. 12 or 14 B. & S. gage copper wire. I have used a clamp like this and find it gives entire satisfaction. The



REPAIRING TEST-TUBES.

Being short of test-tubes and unable to obtain more at the time, I chanced upon the idea of mending some of the broken ones. My first trials were unsuccessful because of the bottom being too thick. I managed to get a good, thin bottom by the following method:



Don't Throw Away Your Broken Test-Tubes. You Can Repair Them Easily. Just Try!

The broken test-tube was lowered into the Bunsen flame and the jagged edges, when soft enough, (still held in the flame) were pulled out with the aid of an ordinary pair of pliers. When the walls seemed thin enough, the jagged ends were drawn together thereby closing the end of the tube as in Fig. 3. The heat was concentrated on "b," Fig. 3, and when soft enough the tip "a" was drawn out (*while held in the flame*). The result appears at Fig. 4. Still holding the tube in the flame, the bottom was heated until soft when it was quickly removed, the open end placed to the mouth, and the breath forced into it. This was done several times until the bottom assumed the shape of that at Fig. 2. Then it was annealed well in the luminous flame and set aside to cool. The result is a test-tube that may be used for all ordinary purposes not requiring heat. The tube may also be used in the flame if the tip of thick glass "d," Fig. 2, is removed with the aid of a grinding wheel or an oil-stone and the tube re-heated and annealed again.

The jaws of the pliers must be hot when it comes in contact with the hot glass and preferably one with narrow jaws and insulated handles. Before introducing the broken test-tube in the flame it must be well heated in the air above the flame to prevent further cracking.

Contributed by HAROLD OLSEN.

SHOP KINKS

Lay dull files in diluted sulphuric acid until they are eaten deep enough.

Chasing Threads in Aluminum: When cutting threads on aluminum use a little oil with coal oil, about (1) one teaspoon of oil to (1) one pint of coal oil, and the threads will not clog up, but will take a fine finish as if cut in steel.

Contributed by CLYDE G. PATTERSON.

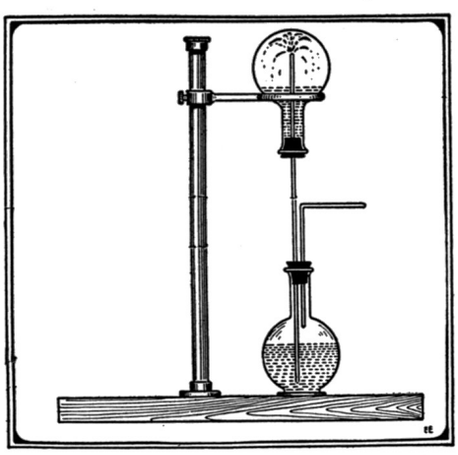
SOLUBILITY OF GAS PRODUCES FASCINATING EFFECTS.

A very interesting chemical experiment can be performed with the apparatus shown in the illustration. A perfectly dry Florence flask is used for the upper vessel. It is filled with hydrogen chlorid gas, which is prepared by heating a mixture of moistened common salt (sodium chlorid) and sulfuric acid. The gas is collected by downward displacement as it is heavier than air.

This flask is connected by means of a glass tube to a similar vessel, which is nearly filled with a blue litmus solution. This solution is made by dissolving a very small quantity of the blue litmus dye in water. The end of the tube, opening into the upper flask is drawn out, so as to make a rather fine jet. All the stoppers are fitted tightly.

By blowing into the open tube of the lower vessel, a few drops of the liquid are forced into the upper flask. The hydrogen chlorid at once dissolves, thus diminishing the pressure inside the vessel. The blue solution then forms a fountain at the jet and continues to do so, until almost all the chlorid is used up. This gas has also the property of changing blue litmus to red, hence as soon as the solution comes in contact with it, the color is changed immediately, thus presenting a very mysterious appearance to a novice.

Contributed by JOHN C. JACK.



The Modern Heron Fountain. A Mysterious Trick of Fascinating Effects.

FIREWORK PAPERS AS PYROTECHNICS.

Red Fire

Strontium nitrat	20	parts
Potassium chlorat	10	"
Alcohol	20	"
Water	100	"

Green Fire

Barium chlorat	20	"
Alcohol	20	"
Water	100	"

Yellow Fire

Sodium oxalat	10	"
Potassium chlorat	10	"
Alcohol	20	"
Water	100	"

Blue Fire

Potassium chlorat	10	"
Copper chlorat	20	"
Alcohol	20	"
Water	100	"

Violet Fire

Strontium chlorat	15	"
Copper chlorat	15	"
Potassium chlorat	15	"
Alcohol	50	"
Water	100	"

Lilac Fire

Potassium chlorat	20	"
Copper chlorat	10	"
Strontium chlorid	10	"
Alcohol	50	"
Water	100	"

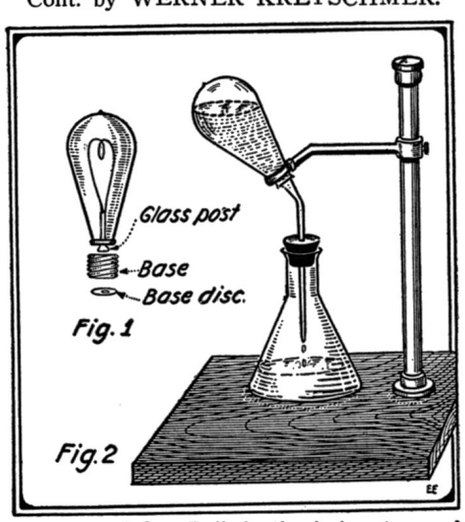
Unsized paper is put in the solutions. When the paper becomes saturated, then remove and dry by hanging it over a string stretched across a warm room. A sheet of paper about 12 by 16 inches may be made to burn for several minutes.

Contributed by BRUCE L. LEWIS.

DROPPER FROM OLD LAMP BULBS.

I have found a very good use to which old worn out electric bulbs can be put. First, the solder is melted from end of the base and the small disc is removed. Now, by using a little pressure, the entire base may be removed. Then, with a piece of heavy wire or a nail, the glass post on which the tungsten filament is attached, can be broken. The glass pieces and tungsten wire must then be removed. Care should be taken to keep the opening at the bottom as small as possible. If the bulb is now filled with water and quickly inverted, the water will not flow out but by slightly tilting it, the water will come out drop by drop. This makes a very good dropper for use in chemical experiments. If a rubber tube is attached as in Fig. 2 the dropper may be used on any receptacle.

Cont. by WERNER KRETSCHMER.



The Burned Out Bulb in the Laboratory. A Cheap and Efficient Dropper!

Electrical Oscillators

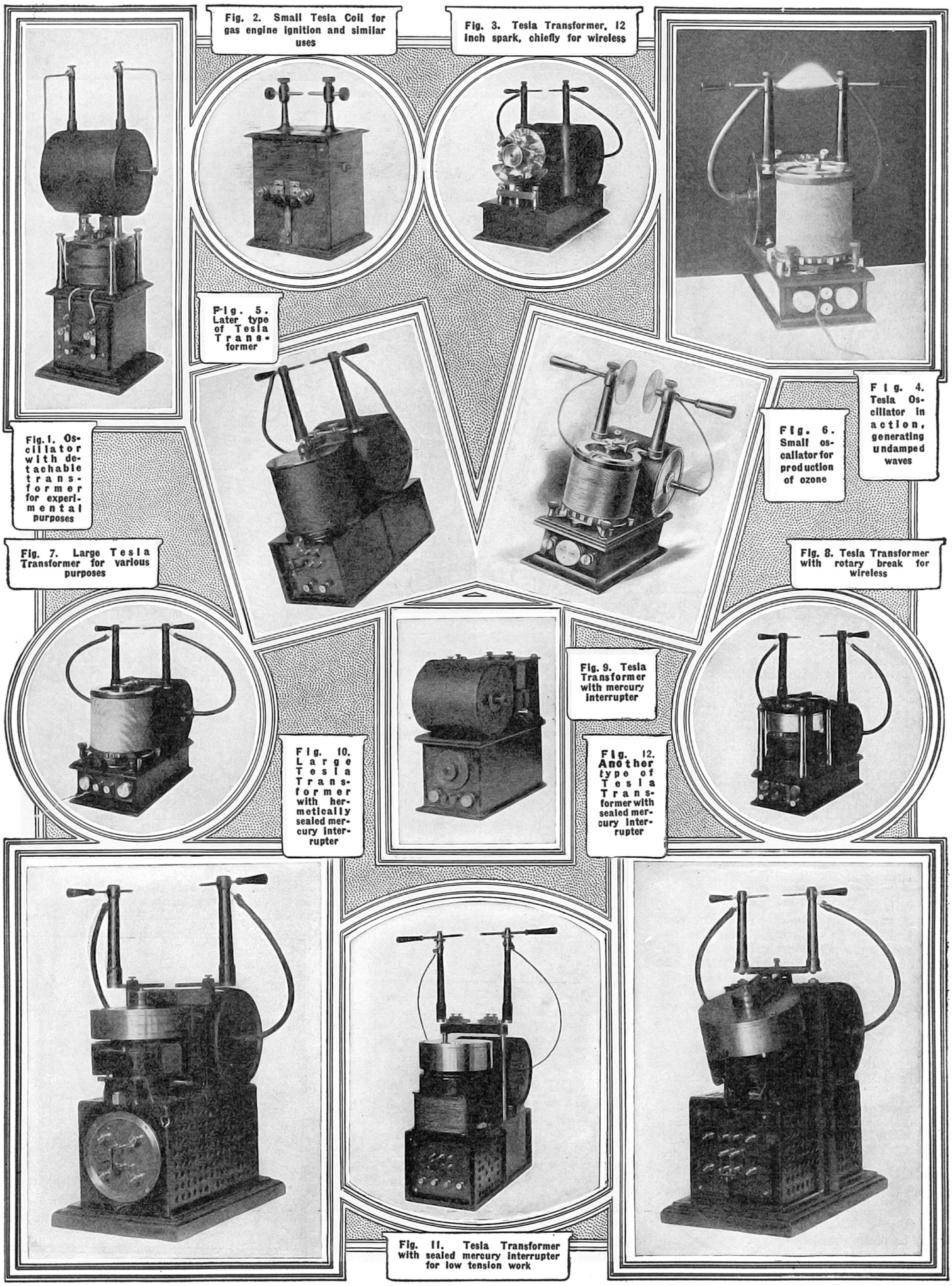


Fig. 1. Oscillator with detachable transformer for experimental purposes

Fig. 2. Small Tesla Coil for gas engine ignition and similar uses

Fig. 3. Tesla Transformer, 12 inch spark, chiefly for wireless

Fig. 4. Tesla Oscillator in action, generating undamped waves

Fig. 5. Later type of Tesla Transformer

Fig. 6. Small oscillator for production of ozone

Fig. 7. Large Tesla Transformer for various purposes

Fig. 8. Tesla Transformer with rotary break for wireless

Fig. 9. Tesla Transformer with mercury interrupter

Fig. 10. Large Tesla Transformer with hermetically sealed mercury interrupter

Fig. 11. Tesla Transformer with sealed mercury interrupter for low tension work

Fig. 12. Another type of Tesla Transformer with sealed mercury interrupter

Electrical Oscillators

By NIKOLA TESLA

FEW fields have been opened up the exploration of which has proved as fruitful as that of high frequency currents. Their singular properties and the spectacular character of the phenomena they presented immediately commanded universal attention. Scientific

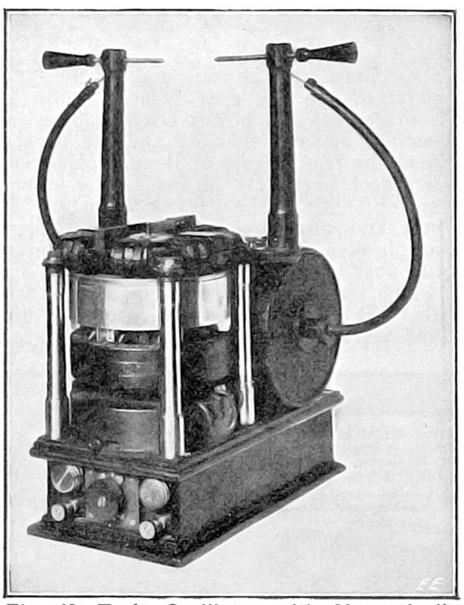


Fig. 13—Tesla Oscillator with Magnetically Controlled, Sealed Mercury Interrupter.

men became interested in their investigation, engineers were attracted by their commercial possibilities, and physicians recognized in them a long-sought means for effective treatment of bodily ills. Since the publication of my first researches in 1891, hundreds of volumes have been written on the subject and many invaluable results obtained thru the medium of this new agency. Yet, the art is only in its infancy and the future has incomparably bigger things in store.

From the very beginning I felt the necessity of producing efficient apparatus to meet a rapidly growing demand and during the eight years succeeding my original announcements I developed not less than fifty types of these transformers or electrical oscillators, each complete in every detail and refined to such a degree that I could not materially improve any one of them today. Had I been guided by practical considerations I might have built up an im-

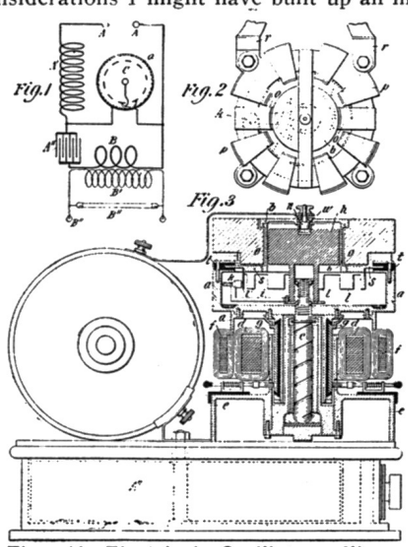


Fig. 14—Electrical Oscillator, Illustrated in Fig. 13, Showing Details and Circuit Connections.

MR. TESLA makes a very important contribution to the electrical arts with this article.

The pioneer of all high frequency apparatus divulges much that is new and startling in these pages. Few people realize the enormous value of Mr. Tesla's machines and the many different important uses to which they can be applied in our everyday lives. New and startling uses are being found every year for these machines.

It is characteristic of Mr. Tesla that he has developed and actually built an astounding variation of these machines, and we regret that we can publish only a very few of the more important models.

Most of the Tesla coils shown have never been publisht before. —EDITOR.

mense and profitable business, incidentally rendering important services to the world. But the force of circumstances and the ever enlarging vista of greater achievements turned my efforts in other directions. And so it comes that instruments will shortly be placed on the market which, oddly enough, were perfected twenty years ago!

These oscillators are expressly intended to operate on direct and alternating lighting circuits and to generate damped and undamped oscillations or currents of any frequency, volume and tension within the widest limits. They are compact, self-contained, require no care for long periods of time and will be found very convenient and useful for various purposes as, wireless telegraphy and telephony; conversion of electrical energy; formation of chemical compounds thru fusion and combination; synthesis of gases; manufacture of ozone; lighting; welding; municipal, hospital, and domestic sanitation and sterilization, and numerous other applications in scientific laboratories and industrial institutions. While these transformers have never been described before, the general principles underlying them were fully set forth in my publisht articles and patents, more particularly those of September 22, 1896, and it is thought, therefore, that the appended photographs of a few types, together with a short explanation, will convey all the information that may be desired.

The essential parts of such an oscillator are: a condenser, a self-induction coil for

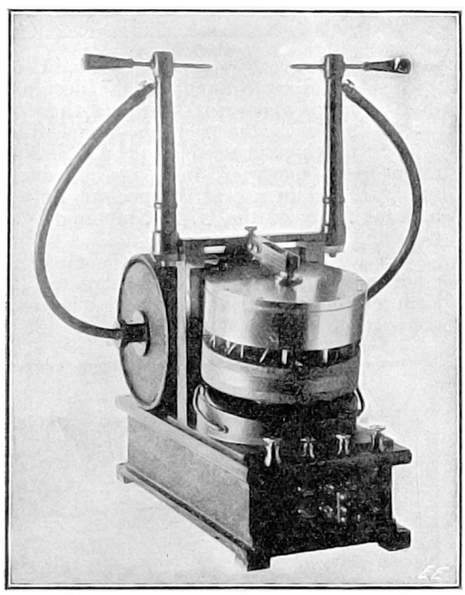


Fig. 15—Tesla Transformer with Gravity Controlled, Sealed Mercury Interrupter.

charging the same to a high potential, a circuit controller, and a transformer which is energized by the oscillatory discharges of the condenser. There are at least three, but usually four, five or six, circuits in tune and the regulation is effected in several ways, most frequently merely by means of an adjusting screw. Under favorable conditions an efficiency as high as 85% is attainable, that is to say, that percentage of the energy supplied can be recovered in the secondary of the transformer. While the chief virtue of this kind of apparatus is obviously due to the wonderful powers of the condenser, special qualities result from concatenation of circuits under observance of accurate harmonic relations, and minimization of frictional and other losses which has been one of the principal objects of the design.

(*Continued on page 259*)

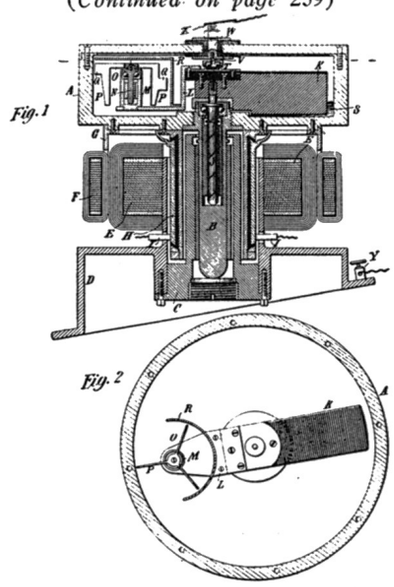


Fig. 16—Electrical Oscillator, Illustrated in Fig. 15, Showing Details of Motor and Break Mechanism.

SPECIAL NOTICE

Last month we announced another special feature article by Mr. Tesla, which altho made in good faith by us was not authorized by him. Due to very important duties of Mr. Tesla, it was impossible for him to furnish his historical article this month, so the special feature article publisht on this page takes its place. An important historical article will appear in the August issue.—Editor.

New 1 K.W. Panel Radio Transmitter

By LESTER F. RYAN

THE great war has wrought tremendous changes in the design of radio apparatus. Among these designs is the 1 K.W. panel transmitting set used by the U. S. Navy on a great many of their vessels during the war, and in use at the present time on a great many of the U. S. Shipping Board vessels.

The 1 K.W. set is one of the most efficient sets in use, being constructed for both efficiency and durability. The panel consists of two bakelite-dilecto pieces mounted vertically, the top panel carrying the hot-wire ammeter as well as the unique-wave changing devices.

The lower panel consists of the A.C.-D.C. voltmeter, wattmeter, the latest design of quenched gap, also the control switches. The panel is 0.5 inch thick. Back of this is the framework upon which the panels are securely fastened. At the bottom is a tray constructed of rigid iron cross-pieces upon which the motor-generator is securely bolted. The motor-generator is driven counter-clockwise from the motor end by D.C., at 120 volts, and is rated 2.1 H.P. at the motor. The generator is rated at 1.25 KVA, or 1000 watts at 80 per cent. power factor. It is of the inductor type, and has 15 poles, and is a 500 cycle machine.

The motor-field strength is controlled by an 18-point rheostat, which varies the frequency between wide limits. The D.C. service switch is rated at 20 amperes, 250 volts.

The automatic starter consists of five distinct parts, two solenoids and two contact discs which are carrjed by plungers working in the solenoids, also a common resistance box. The right-hand solenoid has two separate windings, the first being a *current* winding in series with the motor-generator and starting resistance. The left-hand solenoid has this type of winding solely. The extra winding on the right-hand solenoid is connected across the service line as shown in diagram. This is termed the *potential* winding. The generator field rheostat is a single plate of the iron-clad type, 6 inches in diameter, giving a total resistance of 300 ohms. The control of the rheostat is effected by a handle which is operated from the front of the panel.

The meters are of the Weston type, the A.C. and D.C. voltmeter being of the double-scale design. The resonance inductance which is furnished with this set is of the iron-clad type. It has two windings, one being for full power operation, the second, which is larger inductance, is for low-power operation. Actual operating tests show that the natural period of the A.C. armature, resonance, inductance and transformer primary is 425 cycles. The operating frequency ranges from 450 to 550 cycles.

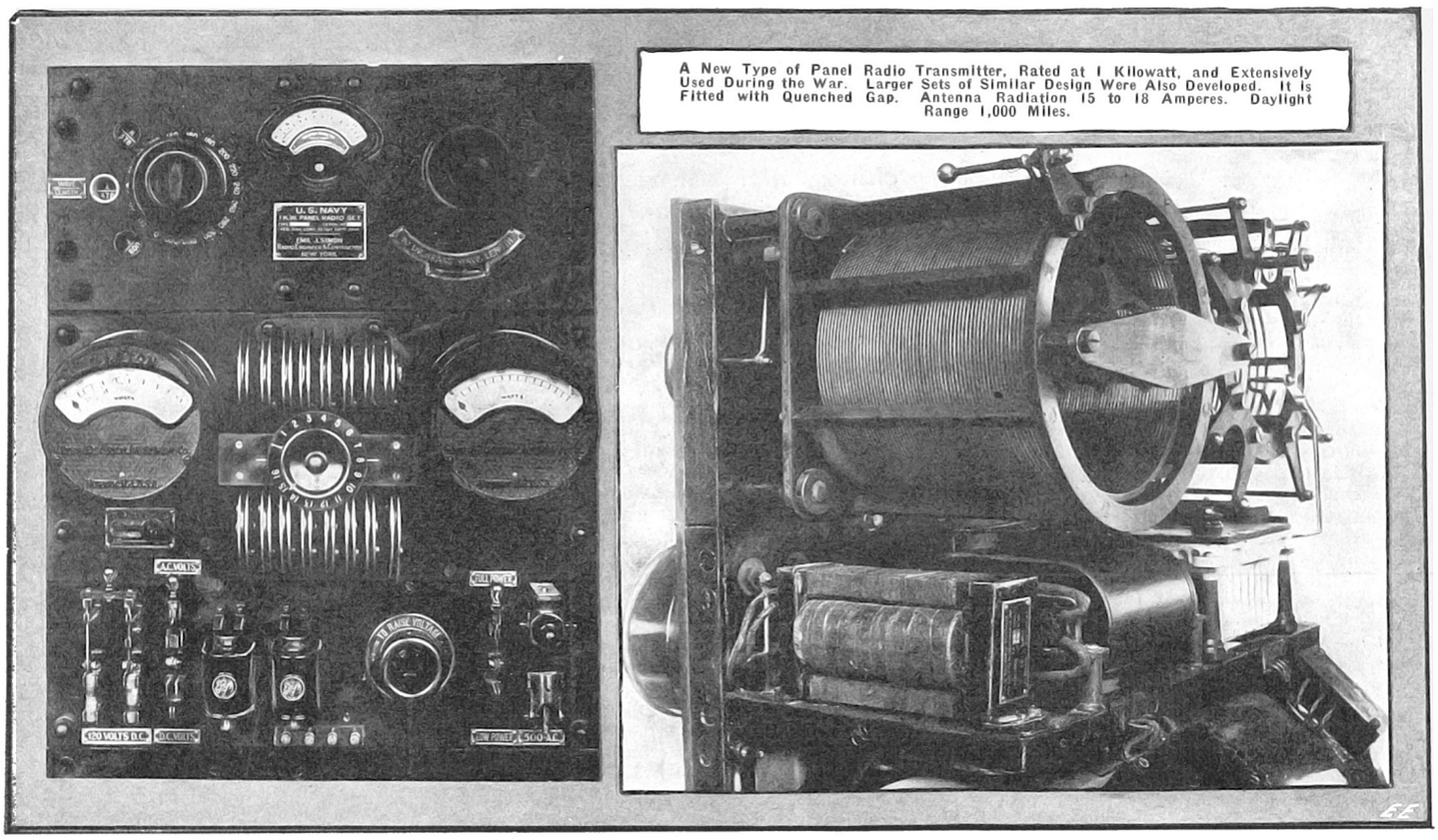
One of the most unique parts of this set is the combination flame-proof Morse key and antenna switch. The key is made with large contacts for carrying audio-frequency currents at low potential. It is encased in a gas-tight housing of black Japanned sheet brass, this housing making the "live" parts of the key free from all electrical contact with the power circuit. The connection between the key and the panel is made by two lengths of flexible cable, each five feet long. By means of the antenna switch, both the generator armature circuit and also the generator field circuit are broken when the switch is in receiving position.

The transformer used in connection with this set is of the closed-core, dry type, and is rated at 1000 watts, 500 cycles and 150 volts at the primary winding terminals. The ratio of transformation is 38 to 1. The transformer is insulated for dielectric stresses of 30,000 volts. The protective gap consists of three balls in shunt with the secondary, forming an inverted triangle, the lower ball being grounded to the frame of the transformer. They are set to stand a potential of 50 per cent above the maximum secondary voltage. The losses in this transformer due to hysteresis and eddy currents are less than 50 watts at full rated load.

The two condensers used are of the Dubilier type of .004 M.F. capacity, and connected in parallel. These condensers are made of select mica, and were tested to show minimum dielectric resistance and hysteresis. Each condenser is mounted in an aluminum housing. This is to insure durability.

The quenched-spark-gap switch is one of the most efficient yet developed. It is in

(*Continued on page* 254)



A New Type of Panel Radio Transmitter, Rated at 1 Kilowatt, and Extensively Used During the War. Larger Sets of Similar Design Were Also Developed. It is Fitted with Quenched Gap. Antenna Radiation 15 to 18 Amperes. Daylight Range 1,000 Miles.

How European Radio "Sigs" are Photographed Here

Messages Can Be Taken at 600 Words Per Minute. Deaf Persons Can Receive Them

PHOTOGRAPHIC receiving and recording of wireless messages as a matter of regular daily routine is now being carried on by naval engineers at the Otter Cliffs receiving station near Bar Harbor, Maine. They use an instrument invented by C. A. Hoxie.

The use of this invention permits the eye to either supplement or replace the ear in reading wireless messages. In fact, a totally deaf man could be a wireless receiving operator in a station so equipt.

It is stated that messages have been deciphered with its assistance, when operators were unable to get a single word of it by ear alone. From now on receivers do not hear by their ears alone.

Thus the outstanding obstacles to accuracy in wireless receiving have been eliminated, except for severe static interference.

Receiving 600 Words a Minute.

As to speed in receiving, this machine has frequently recorded at the rate of 400 words per minute, as fast as a machine gun shoots, and recently in a test made by Mr. Hoxie, the machine recorded a low power message at 600 *words a minute!* Up to this time the most rapid method of recording radio signals has been by the phonograph, but this must still be transcribed by the ear and not the eye. Moreover, no permanent visual record is made. The phonographic method has never yet approached the rate of 600 words per minute, so the new instrument has hung up a new speed record. An interesting sidelight on this feature of the invention is that high speed messages are *secret messages* to all who are not equipt with this device.

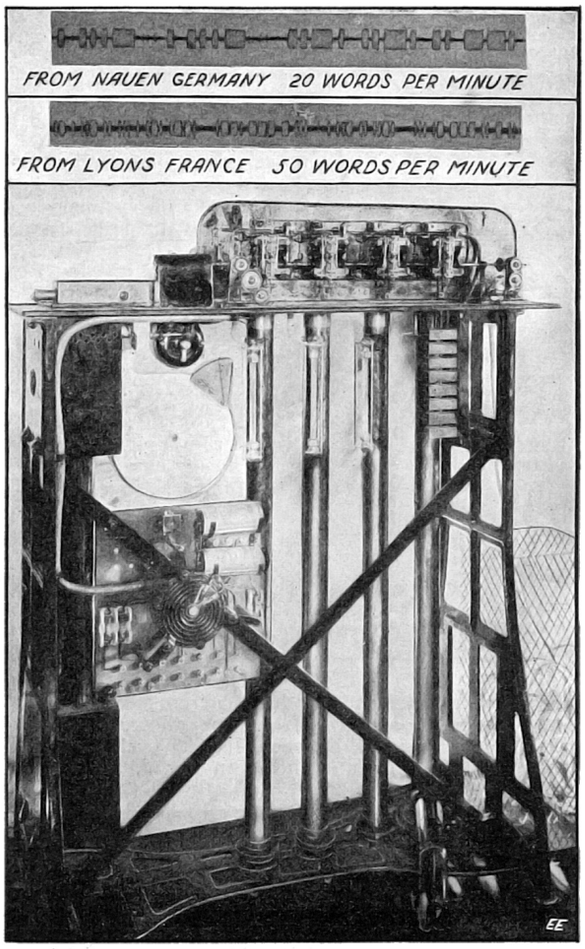
A commercial phase of the speed question is peculiarly linked up with the atmospheric-electric phenomena of the northern temperature zone. For years it has been found that the best time for transmitting all wireless messages between here and Europe was from 4 A. M. to 10 A. M. Speedy sending and receiving can condense the traffic into this most favorable period, or a greater volume can be sent with a minimum number of stations. When it is remembered that a pair of stations—one in Europe and one here—can easily cost $2,000,000—the item of keeping down overhead charges by rapid sending will be easily appreciated.

Expert operators have been known to receive 35 words per minute for a short time under perfect conditions, but average reception up to this time has been 15 to 20 words per minute—or 1,000 words per hour.

It has been a race between sending and receiving speeds. Prior to this invention it has been possible to send the message faster than it could be received, but now the situation has been reversed.

The photographic recorder has been in daily operation at Bar Harbor, Maine. It has repeatedly recorded regular traffic schedules ranging from 1,000 to 7,000 words without interruption; and at a speed of 40 to 55 words per minute every word is perfect and easily and quickly read. It is used supplementary to the ordinary type of receiving set.

Not only is the message permanently recorded on a tape of special photographic paper, but a fleeting visual image of the signals can be seen on the ground glass of the machine at the same instant that the electric impulses arrive from the antenna.



Visual Radio Receiving Device. Tape Starts at Extreme Right and After Being Exposed to Flashes Corresponding to the Wireless Dots and Dashes, is Developed and Dried in the Four Tubes in Center, and Then Runs Off End at Extreme Left Into Basket, the Same as a Broker's Ticker Tape. The Upper Tape is a Reproduction of a Message Sent from Nauen, Germany, to Bar Harbor, Maine, at the Rate of 20 Words a Minute. The Lower Tape is that of a Message Sent from Lyons, France, to Bar Harbor at the Rate of 50 Words a Minute.

Important Articles in this month's "Radio Amateur News"

The Audion and the Radio Amateur
By Dr. Lee de Forest
How I Became a Radiobug
By Thomas Reed
Design of Rogers Ground Antennae
By J. Stanley Brown
Radio Translator
By Major Chas. A. Culver
Announcement of a $100.00 *Radio Prize Contest*
Building a Sustained Wave Radio Telephone Transmitter
By Samuel D. Cohen
New Type of Electron Tube
By H. F. Donle

And even more than this—an audible reception can also be made simultaneously by the regular telephone method.

How the Recorder Works.

The mechanism is based on a comparatively simple electrical engineering principle. A light-weight mirror "flutters" in electromagnetic tune with the minute electric impulses coming from the receiving antenna. The duration and extent of the mirror's oscillations vary according to the dot, dash or silence of the sending station. This mirror reflects a beam of light on the moving sensitized tape. This tape, propelled by an electric motor, progresses up and down thru the vertical pipes which contain the developing and fixing chemicals.

Automatically the tape enters the developing fluid and then the hypo fixing bath; then it is washed in running water, and is dried by electric heat assisted by forced draft—all invisibly effected inside this single machine. Like the tape from a stock-ticker, the message pours out of the wonderful device and into a basket. In rapid receiving there is an average of *one word for every inch of tape.* The receiving operators can read the record at a speed of 50 to 100 words per minute.

The time to record, develop, fix, wash and dry the tape is from *two to four minutes.* The rolls of tape are 1,000 feet long and a continuous message of 10,000 words can be recorded without reloading the machine.

A remarkable performance of this machine only recently promises great things. As told by Mr. Hoxie:

All On One Aërial.

"Two simultaneous messages from different sources were coming in to one receiving circuit connected to the new photographic recorder. One of these messages was sent at a train frequency of 1,000 cycles per second, and the other at 975 cycles per second. Ordinarily two frequencies so close to each other would have interfered with reception, and I was pleased that I could receive one of the messages. But by a slight adjustment of the machine I was able to receive the other message; then back to the first; then switched off to the second—receiving either message without interference from the other.

"I hope to perfect the instrument so that in the not far distant future several photographic recorders can be attached to a single antenna and simultaneously receive messages from Rome, Lyons, Carnarvon, Wales, Nauen, Germany, and San Francisco! This may be called simultaneous multiplex receiving from one antenna.

"When this is accomplished, an international receiving station would have but a single antenna; and in a room inside the station there would be a row of machines with tapes pouring into baskets. One could pause at the first basket and read of the new president of Germany; stepping to the next basket he would read of a volcanic eruption in the Philippines, and only a few feet further on will be the baskets marked 'London,' 'Paris,' 'Rome,' 'San Francisco,' 'Sydney' and 'Shanghai.'!"

It has long been the dream of radio engineers to realize a perfected device for recording accurately wireless signals.

The Pliotron Oscillator

By WILLIAM C. WHITE

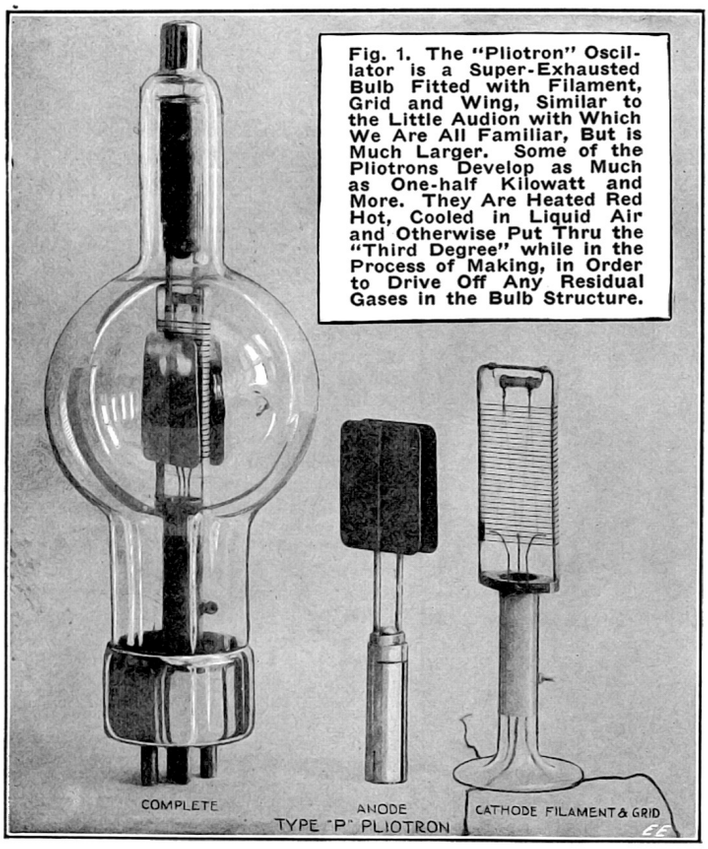


Fig. 1. The "Pliotron" Oscillator is a Super-Exhausted Bulb Fitted with Filament, Grid and Wing, Similar to the Little Audion with Which We Are All Familiar, But is Much Larger. Some of the Pliotrons Develop as Much as One-half Kilowatt and More. They Are Heated Red Hot, Cooled in Liquid Air and Otherwise Put Thru the "Third Degree" while in the Process of Making, in Order to Drive Off Any Residual Gases in the Bulb Structure.

THE *pliotron* vacuum tube when used as an oscillator for the production of alternating current from a direct-current source of energy, has the characteristics of an amplifying relay. That is, the wave shape of any variable electromotive force applied between the electron emitting cathode and the grid (or controlling member) will be faithfully reproduced by the currents in the main anode to cathode circuit.

Therefore, the input of a small amount of alternating-current energy will set up a relatively larger amount, identical in frequency and wave shape. Now by utilizing a small proportion of the alternating-current energy thus produced to feed back to the input circuit, the system can be made self-exciting. Alternating-current energy can thus be obtained from a direct-current source, the pliotron and its auxiliary apparatus forming a type of converter.

The type of pliotron utilized in the arrangements to be described is shown in Fig. 1, and is of the same design as used for the circuits referred to in previous articles.

In this article, two pliotron oscillator arrangements for high-frequency will be described, the first for the production of relatively large current and the second for the production of relatively high voltage. In each case the amount of energy involved is comparatively small, of the order of 150 watts or less.

In a resonance circuit the current will rise until the losses become equal to the input energy. With practical circuits the lower limit of power-factor obtainable is about one-half of 1 per cent., unless unusual precautions are taken. This means that the maximum resonance current produced is about two hundred times the value of the true energy current fed into the resonance circuit.

Therefore, where large currents are desired from a small quantity of energy, the total volt-amperes of the circuit must be kept small; and this condition requires that for such a resonance circuit a large capacity and small inductance must be used.

There is another principle which must be kept in mind. If the amount of electrical energy which can be furnished by a certain source is limited by the definite amount of primary power available, or by the losses in transmission, it is important to so adjust the resistance of the load to the voltage of the supply that the energy is most economically utilized. In the present case this means that the resistance of the heavy current circuit must be given the apparent value most suitable for insertion in the pliotron circuit. This adjustment of apparent resistance is accomplished by electro-magnetic coupling or transformer action.

The diagram of an arrangement to produce currents of from 10 to 25 amperes from one pliotron tube at frequencies between 100,000 cycles and 1,000,000 cycles is shown in Fig. 2.

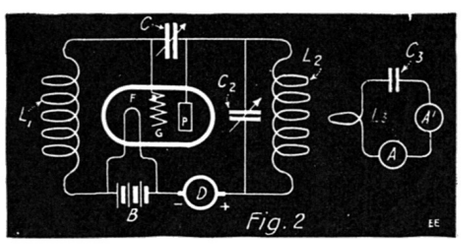


Diagram Showing Arrangement of Circuits to Produce Currents of from 10 to 25 Amperes from One Pliotron Tube at Frequencies Between 100,000 Cycles and 1,000,000 Cycles. Energy Amounts to About 150 Watts.

Suppose it is desired to calibrate a hot-wire ammeter by means of direct comparison with a standard. These two ammeters are represented by A and A_1 and are connected in series as part of a resonant circuit, the inductance and capacity of which are shown at L_3 and C_3 respectively. The product of the values of L_3 and C_3 to be used for any particular case is found by the usual resonance formula:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

As mentioned in a previous paragraph, a low power-factor and volt-ampere product is desirable; and therefore the inductance value of L_3 is made the minimum possible, consisting usually of only one or two turns of heavy conductor. With the range of frequencies specified, this gives values for C_3 of the order of about 0.1 microfarad. In this heavy-current circuit it is of course very necessary to use condensers of low energy loss and to reduce the ohmic resistance of the conductors to a minimum.

The inductance L_3 obtains energy by electromagnetic coupling from the coil L_2 which is located in the plate circuit of the pliotron.

By means of an adjustment of the values of L_1, L_2, and C_1, the pliotron system can be made to set up a high-frequency current corresponding in period to the tuned heavy-current circuit.

Owing to the relative values of L_2 and L_3, the apparent resistance in the plate circuit of the heavy-current load circuit is greatly multiplied, but still is not of a sufficiently high value to absorb all the available energy. To further increase this apparent resistance, a variable capacity C_2 is shunted about the inductance L_2. Then, by simultaneous variation of these two factors, the apparent resistance of the load can be adjusted to give the largest energy output available.

The heavy-current output is dependent upon the voltage of the direct-current source D, a useful range being between 200 and 750 volts.

Pliotrons may be operated in parallel to produce a load current larger than that obtainable from one tube.

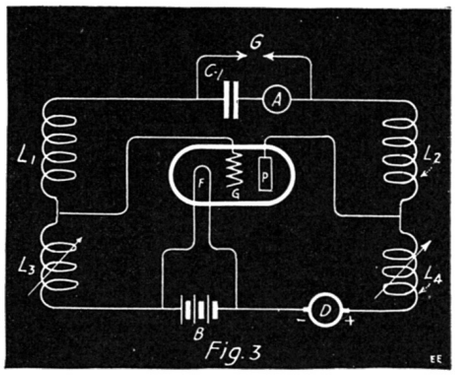
For the production of *high-voltage* in a resonance circuit, the conditions are almost a reverse of those in a heavy-current circuit; that is, with a fixt value of inductance and capacity to give the desired frequency, the capacity must be small and the inductance large, relatively speaking. There is a practical limit, however, to this increasing of inductance and lowering of capacity; and it is reached when the distributed capacity effect in the inductance becomes comparable to the capacity of the condenser used for resonance.

A pliotron oscillator arrangement for the production of high voltages is shown in Fig. 3. The high voltage is obtained across the condenser C_1, and may be tested by the gap G. A condenser in the form of two metal plates suspended in air* is the most convenient, and it may have a capacity value between 20 and 200 microfarads for a frequency of 100,000 cycles. By means of a hot-wire ammeter A in circuit with the condenser and by knowing the frequency, the voltage produced across C_1 may be simply calculated.

The inductances L_1 and L_2 are similar and each has a value of about 8 millihenries. The inductances L_3 and L_4 are also similar to one another and each has a

* Two metal plates, each 10 in. by 10 in. and spaced ½ inch apart, give a condenser having a capacity of approximately 40 micro-microfarads.

(*Continued on page* 287)



Pliotron Oscillator Arrangement for the Production of High Voltages. The High Potential is Obtained Across the Condenser C1, and May be Tested by the Spark Gap G.

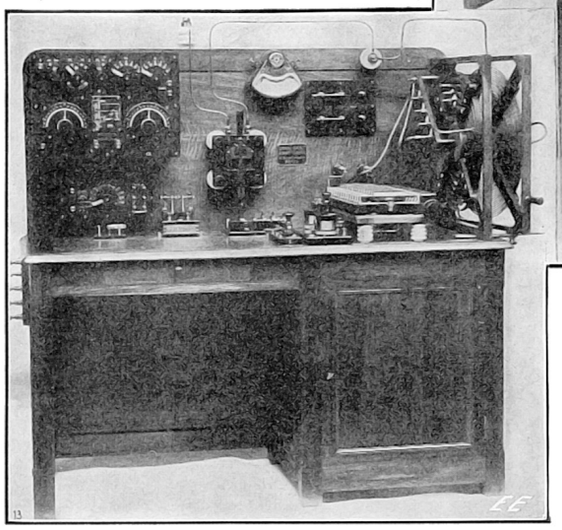
Musical Radio-Telegraphic Sets

By Jacques Boyer

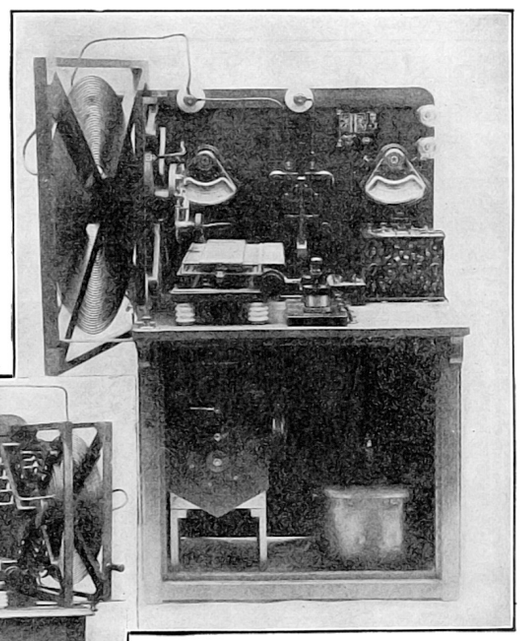
Paris Correspondent, ELECTRICAL EXPERIMENTER

THE French Radio Telegraph Co., "C. G. R.," during the war has perfected a series of very interesting apparatus which it was not possible to describe heretofore on account of the censorship. The apparatus described here are those for sending and receiving by means of audions, particularly for underground work by means of the Rogers system and which were used by the French army. The author will describe for the benefit of ELECTRICAL EXPERIMENTER readers, little by little, several remarkable inventions and telegraphic apparatus used during the war.

The musical sending apparatus described this month comprises two types of 1 and 2 K. W. capacity. The 1 K. W. set here described was used a good deal by the French submarine chasers, and proved highly efficacious. The antenna is energized by shock excitation. The principal property of this excitation is that the antenna gives out a unique wave, its length and amortization (dying out period) being independent of the excited circuits. The musical emission which gives rise to a very high tone is obtained by charging the condenser from a "shock circuit," using alternating current of a frequency of 500 periods per second. This spark frequency of 1000 periods per second produces a very high musical tone at the receiving end.



Top View—New 1 K. W. French Musical Note Radio - Telegraph Transmitter. The Apparatus Is Mounted in a Cabinet Resembling a Desk. A Rotary Spark Gap Is Used Having Adjustment from 0 to .04 m.m.



View of 2 K. W. French Musical Spark Radio - Telegraph Transmitter, Including Receiving Set, Mounted in Cabinet. Note the Spiral Oscillation Transformer.

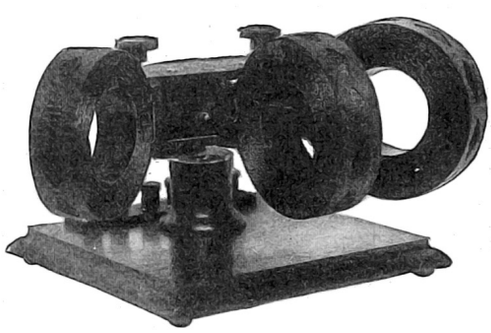
The sending machinery comprises a monophase alternator of 1,820 volt-amperes under an intensity of 7½ amperes, coupled directly with the direct current machine. The inductor of the alternator is fed by a little excitation dynamo which is built right into the alternator. The usual switchboard arrangement is shown in our illustration.

The normal speed of the group is 3,000 revolutions per minute, which gives to the alternator a frequency of 500 periods per second. The transformer employed is of the usual type and is placed in a vessel containing a special grade of oil. The sending condenser is located in a bath of petroleum. The rotary spark gap, which has ten points, is a very accurately built instrument which can be regulated from .04 mm. to 0. Regulation is made

(*Continued on page 278*)

New Honeycomb Inductance

Now that amateur wireless is fast getting back onto a pre-war basis, some very interesting new apparatus is being brought out. Of particular interest to the amateur is a new type of inductance coil developed by Mr. R. F. Gowan, of New York City. It has been well named the "Honeycomb Coil," as can be seen by the illustration.



The Latest Thing in Radio Coils — the "Honeycomb" Inductance. Maximum Inductance, Banked Winding, and Nil Distributed Capacity.

This new coil winding was designed to reduce *distributed capacity* to a minimum and at the same time to concentrate a winding with a large value of inductance, in as small a space as is practicable.

A great amount of research work was done on these coils to determine the most efficient size and spacing of the wire, capacity of the windings, etc. The distributed capacity has been reduced to a minimum and to as low a value as practicable.

By actual measurements it was determined that the high frequency resistance of these coils was only 20 to 28 per cent greater than the D. C. resistance against the usual 100 per cent of the average inductance coil. The coils are remarkably small compared to their inductance values. For instance, a coil one inch wide and about four inches in diameter has a wave length of over 15,000 meters when shunted by a capacity of less than .001 mfd.

Various mountings are furnished for these coils. When properly mounted as a coupler, they make an instrument which cannot be surpast in efficiency and selectivity. Dead end or open winding absorption losses are entirely done away with.

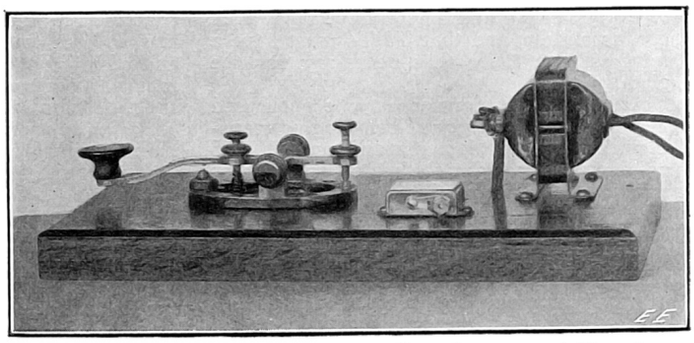
The three coil mounting is shown in the photograph. Here the three coils are used as primary, secondary and tickler. The writer had the pleasure of listening in on a set using this combination with a variable condenser of .001 mfd. maximum capacity in the primary and secondary circuits. The antenna used was a single wire with a natural period of 185 meters. All types of signals from the lowest wave spark set to the extremely long wave undamped stations were received. The sharpness of tuning and amount of regeneration possible on all wave lengths was remarkable. This form of coil is being adopted for many commercial radio outfits, owing to its great space economy.—*Photo Courtesy De Forest R. T. & T. Co.*

New Buzzer Set

An inexpensive outfit for buzzer practise may be easily constructed by any amateur from material obtainable from any electrical supply dealer.

The outfit illustrated is very neat and compact and consists of a bell-ringing transformer, a standard telegraph key and high-pitch buzzer, all wired and mounted on suitable base.

The use of a small transformer eliminates dry cell troubles and produces a note more nearly like that of the large stations. This form of buzzer code practise set, operated as it is from an alternating current step-down transformer, should commend it particularly to schools and colleges where the radio code is taught. For one thing, the tone of the signals given off by the buzzer is more even and regular, and thus resembles more accurately, actual commercial radio signals than is the case where batteries are employed. The operating cost is infinitesimal.—*Photo G. E. Co.*



New Code Practise Set Comprising Key, Buzzer and Step-down Alternating Current Transformer. No Batteries to Bother with and No Operating Expense.

Operate Your Audions on A. C.

By ELLIOTT A. WHITE

FORMERLY INSTRUCTOR IN RADIO, AIR SERVICE SCHOOL FOR RADIO MECHANICS, CARNEGIE INSTITUTE OF TECHNOLOGY

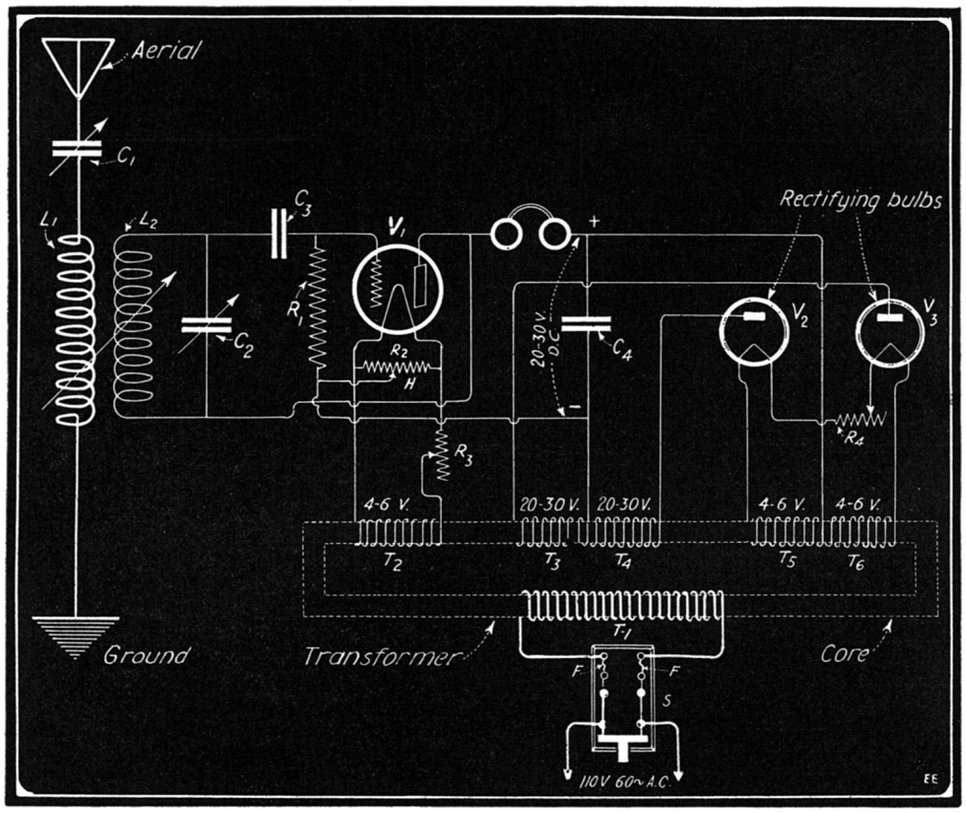
I OPENED my Radio Receiving Station with a sensitive regenerative receiving set using vacuum tubes, but with **no storage battery for the filaments or dry cells for the plates,** running my tubes entirely on ordinary 60-cycle **Alternating Current** tapt off the electric light fixture. The accompanying figure shows how it is done.

Altho any regenerative hook-up will serve, the one I am using with good results for receiving both damped and undamped waves has the antenna circuit C1 L1, and the secondary circuit L2 C2. The secondary circuit is connected on one side to the plate, and on the other side to the detector grid, thru a stopping condenser C3 of .00015 microfarad capacity. This is a familiar hook-up thus far. The new wrinkle is in substituting A. C. (alternating current) for the storage battery to light the filament, and *rectified* A. C. for the high voltage dry cells to operate the plate circuit.

A transformer is necessary to furnish the low voltage for lighting the filaments of the receiving tubes, detector V1 and amplifiers (not shown), and also the filaments of the rectifier tubes V2 V3; and to furnish high voltages for the plates. The windings of the complete transformer are as follows: the primary T1 connected to the 110 v. or 220 v. A. C. lighting circuit; a secondary T2 to step this down to 4—6 volts for the detector (and amplifier) filaments; a secondary T3 T4, to give 20—30 volts from each half (or 40—60 between end terminals) for the plate; and another secondary T5 T6, to give 2—4 volts or more from each half (or 4—8 or more between end terminals) for the filaments of the rectifiers, the voltage required depending on whether they are connected in series or in parallel, as either connection is satisfactory. It is seen that windings T3 T4 and T5 T6 have taps taken off the middle, and that T3 T4 must have a total voltage *twice* that necessary for the plate.

Altho the transformer may be purchased in the form of two toy or bell-ringing transformers for the filaments and one 110—55 volt transformer for the plate (with tap in middle of 55 volt winding), all the primaries being connected in parallel, it is easy and convenient to wind a single transformer to run the whole set, as the low voltages and small currents permit the use of small wire and few turns. In a closed-core transformer the windings may easily be computed from the familiar equation $E = 4.44 \phi f N 10^{-8}$ or $N = \frac{E}{4.44 \phi f 10^{-8}}$ where E is the voltage for that particular winding, ϕ the flux per sq.in. of core which may here be put at 60,000, f the frequency, here 60, N the number of turns required per sq.in. cross section of core, and 10^{-8} is 1/100,000,000, giving $N = \frac{.625 \times E}{A}$ where A is cross sectional area of core in sq. in. In other words, to find the number of turns needed in any winding, divide the voltage of the winding by the area of cross section of the core and then multiply by .625; that is, the number of turns needed for 60-cycle current and a flux density of 60,000 lines per sq.in. is six and a quarter times the required voltage divided by the area of the core. For example, if the core is say 1 in. by 3 in. (the one I used), the area is 3 sq.in. and the number of turns is therefore approximately twice the voltage, or *half a volt to a turn.* For the winding T1, which is connected to the supply, this gives 220 turns for a 110 volt supply (or 440 turns for 220 volts); for T2, 12 turns for 6 volts, and so on. In such a transformer, small and of low power and intermittent service, it is not necessary to be exact, so long as *the ratio between turns on primary and secondaries is always the same as the ratio of their required voltages.* Any core area can easily be substituted in the formula mentioned above—$N = \frac{.625 \times E}{A}$

The size of wire depends only on the current carried. As each filament draws a little over an ampere, any size which will carry this will do for T2, unless the winding supplies amplifiers as well, in which case they must be allowed for; V2 V3 will draw about 2 amperes if in parallel or about 0.5 ampere if in series. It is therefore convenient to use ordinary No. 18 bell wire for the windings T2 T5 T6, if no larger wire is on hand. Wire as small as No. 30 cotton or enamel covered is good enough for windings T3 T4, as the amount of current is negligible, tho No. 24 cotton or enameled wire or larger is better as it is not so likely to break. As the whole transformer will draw 3—5 amperes at 4—6 volts on the low side, depending on the number of amplifiers used on the set, we can allow 35 watts as the maximum power consumption (running over 3 hours for a cent), or say 0.5 ampere on the supply side, allowing for the magnetizing current. In spite of the small current, however, it is best to use wire as large as No. 18 or No. 14 for winding T1 as well as for T2 T5 T6. My transformer, for example, is wound as follows: T1, 220 turns No. 18; T2, 12 turns No. 18; T3, 45 turns No. 24; T4, 45 turns No. 24; T5, 8 turns No. 18; T6, 8 turns No. 18 (rectifier filaments in series). Of course these details depend on the materials on hand, such as core and wire. The taps and terminals can be brought out to ten binding posts on a small board or piece of fiber clamped to the core, and the whole put inside an iron transformer case or tin cracker box to avoid "cross talk" with the set, as will be mentioned later.



The Greatest Advance in Audion Operation Yet—Run Them with Alternating Current. The Accompanying Text Tells How to Build the Step-down A. C. Transformer which Supplies the Proper Potential Current for the Filament and Plate. Tungar Rectifier Bulbs or Even Old Audions Serve to Rectify the A. C. for the Plate Circuit.

The detector V1 is an ordinary 3-electrode audion receiver tube, but preferably of the new *high vacuum* type manufactured during the war, which requires no close adjustment of filament current or plate voltage but operates on 1—1.1 amperes for the filament and, for the plate, approximately 20—25 volts as *detector,* and approximately 40—45 volts as *amplifier.* If the high vacuum type is used, a grid leak R1 is required, of about 1 megohm (1,000,000 ohms) when oscillating or 2 megohms when not, if the grid circuit insulation is good. The leak may be a pencil line drawn on card or fiber and may vary considerably in resistance.

For the rectifiers V2 V3 ordinary receiving tubes may be used, again preferably *high vacuum,* with grids connected to plates; or, if obtainable, two-electrode tubes may be used, such as the Kenotron or Tungar *rectifier tubes* now available on the market. There is no reason why the experimenter may not construct them by inserting a disk in a tungsten filament light bulb and re-exhaust with a vacuum pump.

Besides the transformer and rectifier

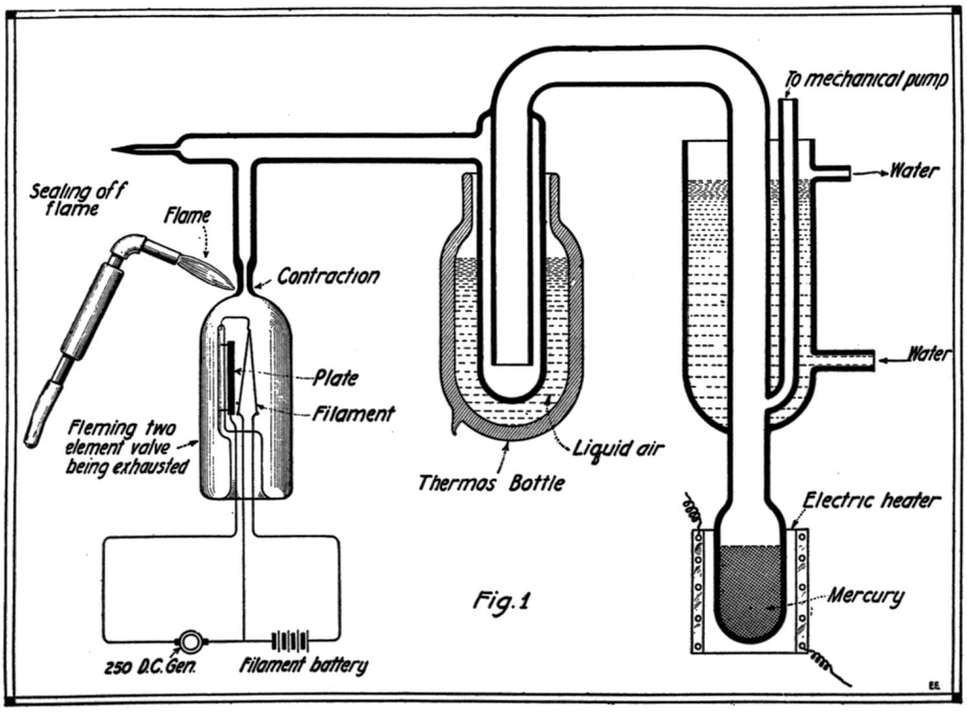
(*Continued on page* 266)

The Design, Pumping and Testing of Audion Tubes

By C. MURRAY

THE purpose of this article is to bring out some of the salient points which might be of interest to the amateur radio experimenter on the design, pumping and testing of the vacuum tube detector and amplifier, or so-called *Audion*. All of these tests I have conducted in my laboratory and I have plotted curves to show the exact relations one element has to another.

The *Fleming valve* is the true rectifying detector, but Dr. de Forest, by inserting the *third element* in a vacuum tube, created a genuine relay, or energy control detector, which gives it a great many advantages over the two-electrode Fleming valve. The three-element Audion can be used as an oscillator, amplifier, and a detector of both damped and undamped waves; also it can be used as an undamped wave generator for use in either radio-telegraph or telephone transmission, whereas a two-element tube can only be used as a detector of damped waves or the ordinary spark signals.



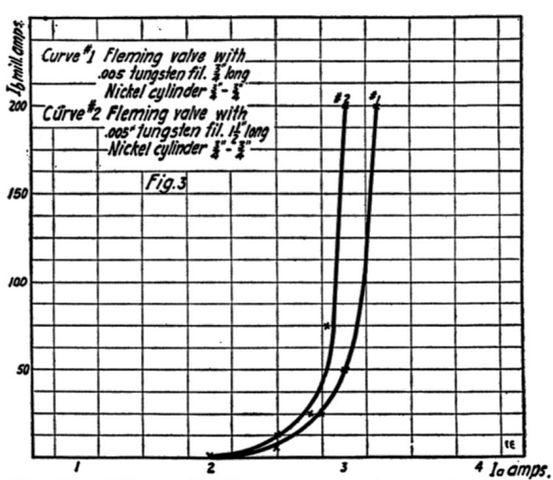
Apparatus Used to Produce Super-Exhaustion in Audion Bulbs by Means of the Liquid Air Trap. This High Degree Vacuum Pump Is Backed Up by a Regular Mechanical Pump as the Diagram Shows. This Is the Regular System Used Commercially During the War in Turning Out Thousands of Audions Daily.

The characteristics of a given three-element tube depend almost entirely on the grid, its surface area and its distance from the plate and filament.

The dimensions of the three elements vary according to the uses of the tube, altho all designs are interchangeable to a certain extent and will work with a fair degree of efficiency in any rôle.

There are several abbreviations that are used in the testing of vacuum tube detectors and amplifiers, and I have used some of them in plotting the present curves:—

Ea = voltage across the filament.
Ia = current consumed by the filament.



Showing Effect of Filament Length on the Space Current Passing Between the Plate and Filament. The Longer Filament Can Be Run at a Lower Temperature to Give the Same Results with a Longer Life.

Eb = voltage imprest on the plate.
Ib = current passing between plate and filament.
Ec = voltage imprest on the grid.
Ic = current passing from the grid to the plate.
Io = current in the oscillating circuit.

The filament plays a very important rôle in vacuum tube work. It must be of such material that when heated to incandescence it will give off electrons, which form a conducting path; or, in other words, a current of electricity will pass thru the space (in one direction only) from the hot to the cold electrode.

The filaments used most extensively to-day are tungsten wire and platinum ribbon coated with various chemical compounds, such as calcium oxid, barium, strontium nitrat, sulfur and lime. Many other mixtures have been experimented with, yielding good results.

The coated filament gives the best results and has one advantage over tungsten; it consumes less filament current to produce the same results, as can be seen by referring to the curves plotted for two Fleming valves, Fig. 2. Both filaments are the same length and Eb is kept at 200 volts during the test.

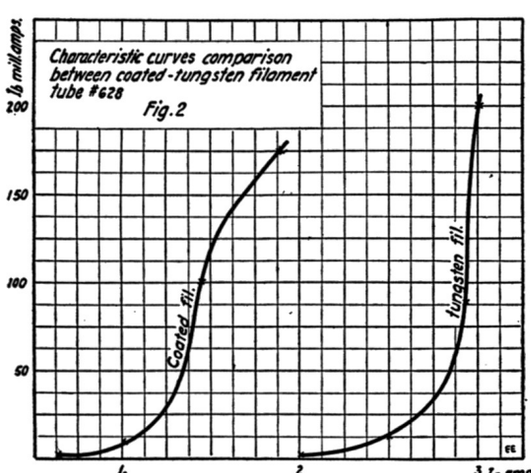
Tungsten emits very few electrons at a low temperature. The value Ib increases very rapidly as the filament temperature is raised.

The length of the filament also has some effect on Ib, as can be seen in Fig. 3. One tube has a tungsten filament ¾ inch long and the other 1½ inches long. It is seen that the longer filament can be run at a lower temperature and it will give the same results, besides giving it a longer life.

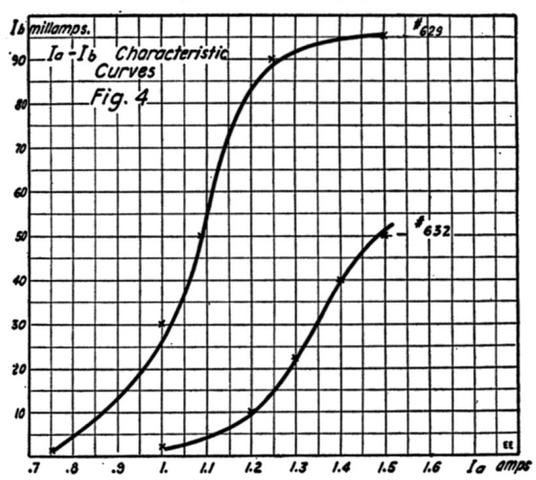
The proper length of filament to be used is determined by the voltage of the filament battery; also we must take under consideration the size of the plate, the amount of plate current to be past and its voltage.

By using too small a plate or too short a filament we will be limited in the amount of plate current we can pass, as by referring to Fig. 6 we will find a point of saturation; that is, if we raise the filament temperature still higher the valve Ib will remain at a certain point. Likewise it is true of the plate; suppose we design a tube to work at 150 volts Eb and a space current of 30 milliamperes; we can raise the Eb even to 200 and the Ib will remain the same.

(*Continued on page* 264)



Comparison Between Filament Currents of Coated and Plain Tungsten Filaments for Audions, Showing the Smaller Current Taken by the Treated Filament.



Characteristic Curves for Two Fleming Valves with Different Size Cylinders. During the Tests Eb Was Kept at 200 Volts and Ia Was Varied Until a Saturation Point Was Reached.

How Don Flashed the "S. O. S."

By MABEL M. DAVIS

DONALD JOHNSON'S mother says she feels sure the careless nursemaid they had when "Don" was a baby must have mixed an *electro-lytic solution* with the milk he was fed. She cannot believe that otherwise any boy could be so permeated with electricity. He could not have caught it from his family as he was an only child, and his mother could not tell a fuse-plug from a dry battery, and his father's abilities in electrical matters were all confined to paying the electric light bill on time each month.

It was different with Don's chum Will Merton. He was the youngest of a large family, all of whom were wound up and went by electricity, and that was their sole motive power.

The story of all the weird and wonderful inventions and imitations of inventions that were produced by these two boys in Don's "Lab." would fill a book. One worth while and early accomplishment was the mastery by both boys of the International Morse code and they often flashed or tapt out signals to each other from various points in the neighborhood.

One evening near dusk "Don" was hurrying home from their favorite resort, the dumping grounds of the Ajax Electrical Company's factory. He heard a faint mewing that seemed to come from overhead and looking up he finally located a cat at the very top of a nearby electric light pole. The nine-lived feline was crying pitifully and Don's sympathies were touched. Being a senior in high school, Donald was rather ashamed of showing any fondness for cats. But he glanced this way and that and not a soul was in sight. So he made a jump and a scramble, hoping to shinny up to the first spikes on the pole. He did not make it and realized for the first time how heavily he was loaded. In the pockets of his mackinaw he only had a piece of zinc rod, a large magnet for a telephone magneto, some brass rod, copper tubing, a pocketful of assorted screws, bolts, nuts, washers, another pocketful of lengths of iron core wire, and nearly a pound of miscellaneous binding posts. So he cast his treasures from him—coat and all and went to the rescue.

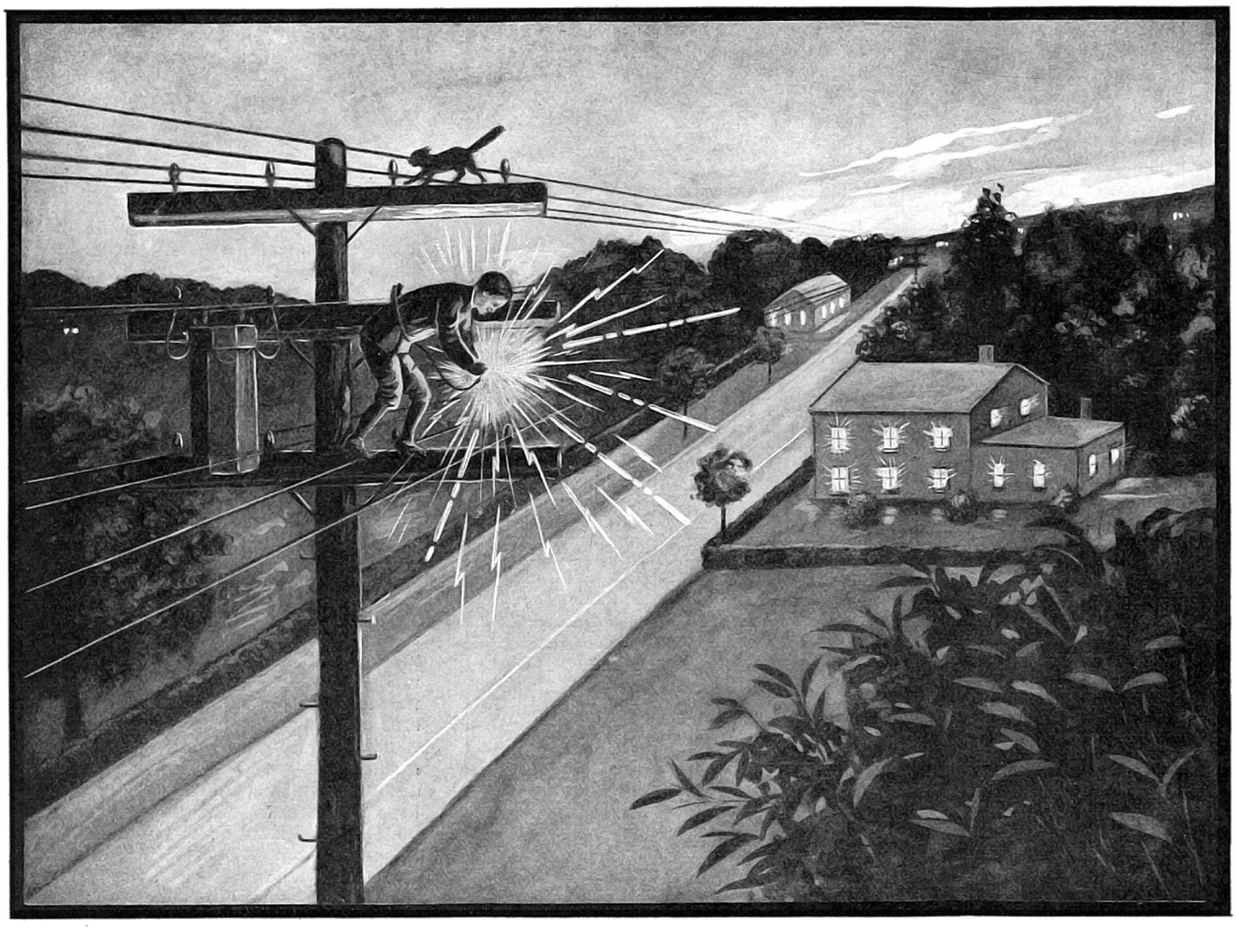
After a hard scramble he gained the spikes and climbed quickly up. Standing on the lowest cross-arm he tried to persuade "Pussy" to come down within reach, but she was suspicious of the proffered help and remained fast at her post. He gained the next arm and his persuasiveness brought her down a little way. He reached for her but she backed out to the end of the arm, over his head. Donald followed along to the end of his cross-arm when horrors, his foot slipt and he started to fall. Donald never could tell just how it all happened, but he suddenly found himself with his two feet on the cross-arm below and the peg of the arm above hooked thru the belt of his Norfolk coat. In falling his foot had struck the glass, broken it, released the wire, and, as his body slid by the peg it had hooked him. Luckily, his belt had held until his feet found the arm below and relieved the strain a little. He was in a very awkward and uncomfortable position. He tried cautiously to squirm about and get the belt off the hook, tho he was very much afraid that if he succeeded he might not be able to hold on to the cross-arm without the support of the stout peg under his belt.

Fortunately his belt was securely buckled in front, not buttoned. He twisted and tried to turn, finally fingering his belt to see if he could unbuckle it in case he got up his courage to try it. But that question was not to be put up to him to decide as the buckle had slipt around to the back and with all his squirmings he could not get it within reach of his fingers.

He rested with one arm over the cross-arm, his feet very insecurely placed on the cross-arm below, and the pole too far away to reach. He tried a few yells for help but they cracked in delivery, so he gave that up.

He had come across lots from the factory and struck into his own street near the end of it, where there were no houses for a long distance and rarely a passerby.

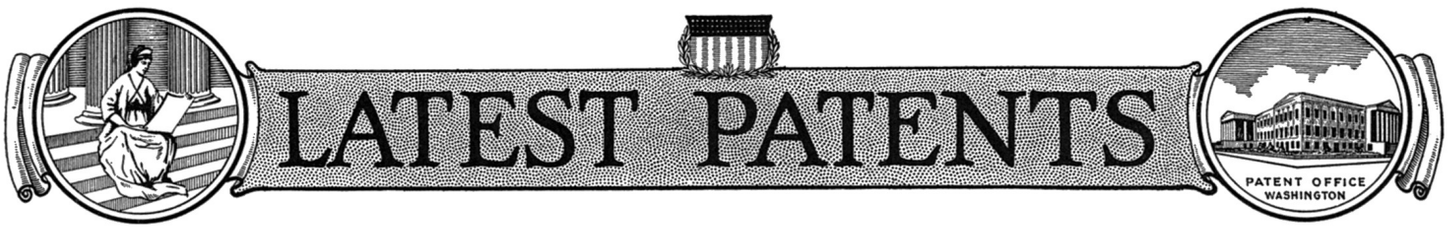
Another factory recently built on a side street had caused the electric lighting company to put up a transformer for that neighborhood. "Don" and "Will" had watched and assisted at the installation of that transformer. The cat had chosen to ascend the very pole that held the transformer. As it began to get dark "Don" noticed the humming of the transformer increasing. He could see Will Merton's house away down the street. Their lights appeared and "Don" could imagine the family all gathered about the supper-table.



The Cat Had Chosen to Ascend the Very Pole that Held the Transformer. As it began to Get Dark "Don" Noticed the Humming of the Transformer and He Could See Will Merton's House Lighted Up Down the Street. Try as He Might, He Could Not Extricate Himself from the Cross-Arm. Suddenly a Bright Idea Flashed Across His Mind—Why Not Cut the "Secondary" Low Voltage Wire and by Interrupting the Light Current, Signal His Dilemma by Dots and Dashes, to His Friend Will Merton.

The transformer was humming louder now. An idea suddenly came to Donald. After a terrific squirm he succeeded in getting the fingers of his free hand on the chain of his wire-cutters which, out of school hours, he always carried attached to his person. With the wire-cutters clasped firmly in his right hand he reached for the secondary lead of the transformer which hung in a loop over his head. He knew that it was safe enough to tackle that wire without gloves, as it carried only 110 volts. It was hard work and took a long time, but the trusty wire-cutters did the trick. There was a blinding flash and the loop was cut. Donald could see that the Merton's house and others nearby were dark. He grasped one wire in his right hand, then by touching this to the other, which hung loose, he caused a short flash of light in all the houses, then followed this by two long flashes, which was his chum's private wireless call. He repeated this carefully, then

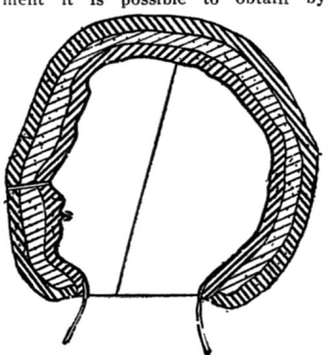
(*Continued on page* 275)



Process of Galvanoplasty.

(No. 1,296,453, issued to Blasius Bart.)

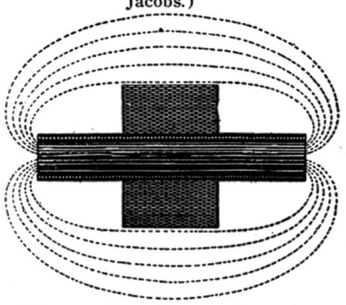
By means of this new development it is possible to obtain by



means of electrochemical steps, copies in all sizes, reproducing every feature and detail of the model. The copies can be made entirely in one piece having uniform thickness. A matrix is placed upon the model and so fixt that it will reproduce each detail. This matrix is composed entirely of a metallic substance of high electrical conductivity to receive the electrolytical deposits. A means is also provided whereby a non-conductive covering can be applied on the matrix where no electrical deposits are required. One wire is then connected with the matrix and the other to a sprayer or atomizer, whereby a metallic composition is used to cover the surface of the metal.

Spark Coil.

(No. 1,296,963, issued to George A. Jacobs.)

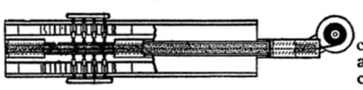


Most spark coils are dependent on the air for return magnetic circuit between both ends of the core. To overcome this difficulty of the high magnetic resistance of the air, the inventor employs soft iron wires for the secondary winding, thereby helping to partially close the external magnetic air circuit. It consists essentially of the usual core over which insulation is placed and then a primary coil of heavy copper wire; on the insulating tube over the primary is a winding of fine insulated iron wire, forming the secondary.

Apparatus for Sherardizing.

(No. 1,291,866, issued to Herbert Champion Harrison.)

This invention consists of a new and simple method of sherardizing articles which are of narrow width and great length, such as wire or ribbon material or small cross-section bars, etc. It consists essentially of an elongated chamber containing the sherardizing powder. A second

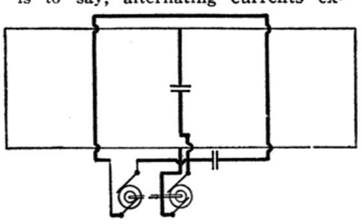


chamber also contains this powder. The third chamber contains an air seal and substantially cold sherardizing powder adapted to gradually reduce the temperature of the article after the sherardizing re-action. The second chamber containing the sherardizing powder also has a hopper above it, so that the sherardizing powder can float freely into the chamber. A movable system of taking up the long ribbon or wire for carrying it thru the various chambers is provided and an electric pyrometer is used.

Aërial for Radio Signaling.

(No. 1,296,177, issued to Charles Franklin.)

Makes use of two equal rectangular or frame aërial circuits erected in the same vertical plane so that they have one vertical edge common to both (or parallel). The two circuits will have no mutual inductance or coupling effect on one another if they are properly proportioned; that is to say, alternating currents ex-

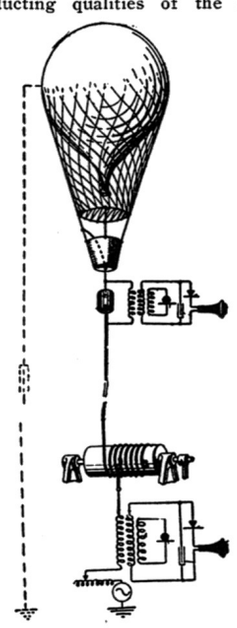


isting in one will not affect alternating currents existing in the other. Under these conditions each circuit tends to produce its own radiation independently of the other circuit. The radiation will then have a maximum value in one direction only, gradually diminishing in value to zero at 90 degrees on either side of this maximum direction, and being practically zero thruout the other 180 degrees.

Signaling from Balloons.

(No. 1,296,687, issued to Harold W. Nichols.)

A unique method for signaling to and from captive balloons over the single steel cable by which the balloon is anchored to earth. No additional wires are necessary in this scheme. This invention employs the conducting qualities of the single

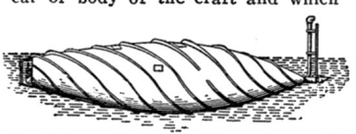


cable connecting the balloon to earth as one side of the circuit, and the circuit is completed by virtue of the electrostatic capacity between the balloon and the ground. To enhance this effect, the balloon may be covered with tin-foil for a portion of its area, or the rubber covering otherwise metallized.

Submarine Destroyer.

(No. 1,296,646, issued to George H. Georgelis.)

The craft illustrated has an exterior hull so that it is continuous and adapted to rotate about the car or body of the craft and which

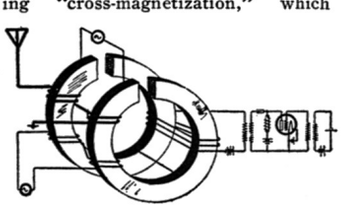


is driven for propelling the craft thru the water at a high rate of speed due to exterior spiral fins mounted on the hull. A sharp steel prow or ramming point is provided at the forward end of the submarine destroyer, as well as periscopes for locating enemy craft, subsea and wireless telegraph apparatus, anti-submarine guns, etc. The hull may rotate about the shaft and periscope plug without disturbing the position of the periscope. The hull is mounted upon a plurality of rollers which constitute bearings between the hull and the shaft. A suitable motor or engine is employed for propelling the craft.

Modulating System.

(No. 1,287,982, issued to Ralph V. L. Hartley.)

The quality of the speech transmitted by ordinary magnetic modulators is relatively poor, as the modulated high frequency wave form is distorted by the hysteresis of the magnetic core used in the modulator. In the present modulator this hysteresis of the magnetic core is reduced by subjecting the core to a relatively weak but rapidly alternating "cross-magnetization," which

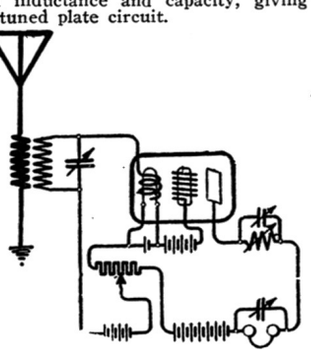


keeps the molecules of the iron in a constant state of agitation, rendering them more susceptible to changes in the longitudinal magnetization produced by the modulating speech currents.

Radio Receiving System.

(No. 1,291,527, issued to Albert W. Hull.)

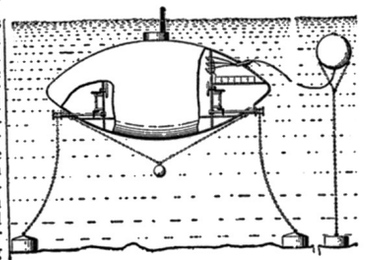
A vacuum tube device intended for amplifying variable currents, particularly received radio signals. This patent covers an improved circuit arrangement in which a four-electrode audion may be utilized for receiving radio signals, whereby the sensitiveness and selectivity of the receiving circuit may be greatly increased. By this arrangement undamped wave signals may be received by means of the "heterodyne" or beat method. A special telephone circuit is utilized in connection with an inductance and capacity, giving a tuned plate circuit.



Submersible Mine Controller.

(No. 1,296,816, issued to Jan A. and Albert Krecioch.)

The submersible feature of the outfit permits the unit to submerge and thus protect itself should the occasion demand it. The operating devices include a switchboard, to which are connected the various circuits connecting with the mines lying in different numbered sections of the adjacent water. When an enemy ship lies within the numbered square corresponding to the mine of that number, then the officer in

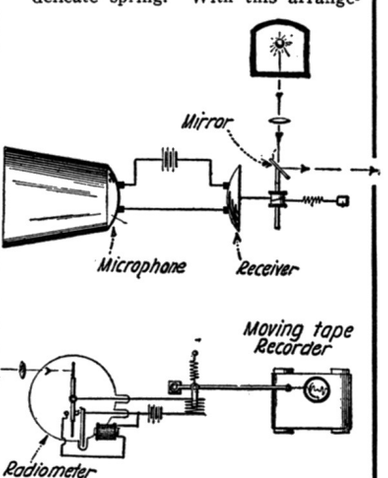


charge closes the switch and that mine or any group of mines instantaneously explodes. Observation may be carried on by a periscope.

Apparatus for Recording Sounds.

(No. 1,294,861, issued to Lindon W. Bates.)

This idea mainly consists of a means of using the oscillations produced in the receiver by the sound waves to produce oscillations of light waves, which in turn will break an electric circuit. The time of breaking of the circuit is recorded by a standard recorder and also its duration. These several operations are practically instantaneous. The time of breaking may be taken as the time for the receipt of the sound in the detector. A horn or microphone is used for collecting the sound waves and directing them to a microphone attached to the diafram of the receiver, on which a thread of silk passes around a drum, after which it is attached to a very delicate spring. With this arrange-



ment vibrations imparted to the diafram and microphone will cause the compression of the granules of carbon, the microphone thereby setting up a current in the receiver. This in turn pulls the fine silk thread on the drum, and to the spindle of the drum is attached a mirror with a light shining on it. This pulling back and forth of the drum causes the changes in the light waves which are taken up by a radiometer, and by means of relays the current so set up actuates the drum stylus and records the sound waves.

WITH the AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light-toned ones. We pay $3.00 each month for the best photos. Address the Editor, "With the Amateurs" Dept.

"Amateur Electrical Laboratory" Contest

THIS MONTH'S $3.00 PRIZE WINNER—R. L. FRIESS

I GIVE herewith several photographs of my laboratory. My laboratory measures 8 x 12 feet, and is fitted with gas, running water and electric lights. I have one corner fitted up for study work, which has a 2 x 3-foot top table and drawer, which I made myself; two card files; cabinets for books, which are only soap boxes, and about $250.00 worth of books on mechanics, chemistry, mathematics, electricity, and four volumes of the Universal Dictionary of the English language; twenty-nine volumes Encyclopedia Britannica; also many other books of use in my studies.

In my laboratory I have about 200 chemicals, a good line of chemical apparatus which netted me about $300.00. I have some electrical apparatus, some of which I made myself. I have an electrical as well as a gas furnace which I made, giving a temperature of about 3,000 degrees Fahrenheit. I am taking a course with a correspondence school, covering general chemistry, and do a good deal of analytical work in my laboratory, besides magneto and coil repair work. I have performed a number of interesting experiments in electricity and chemistry.

Am going to fix up my radio station in the near future and bring the antenna up to date (a la Rogers). I heartily request any amateur to write me with regard to any trouble he may have in mathematics, chemistry, electricity, etc., and I will help him to the best of my ability.—R. L. Friess, 148 S. Summit St., Bowling Green, Ohio.

HONORABLE MENTION (One Year's Subscription to the ELECTRICAL EXPERIMENTER) —JEROME SACKHEIM

I HAVE been for a number of years a close student of electricity and chemistry and the newer art, Radio. During this time I have carefully followed many of the important new advances described in the ELECTRICAL EXPERIMENTER, of which I am a constant reader. I am sending herewith photographs which show my combined electrical, chemical and radio laboratory, and in which I have spent many pleasant hours conducting new experiments and listening to signals. Owing to the war, I have devoted more of my time to chemistry than to any other subjects, which you will note by the large array of chemicals, also many important pieces of chemical apparatus. I am 16 years of age, a high school student and greatly interested in the scientific arts. In my radio set I have several variometers, 2,000-ohm head sets, receiving condensers, detectors, loading and tuning coils; also a small transmitter which I cannot use as yet, 1" spark coil, condenser, oscillation transformer, spark gap, key, etc. In my little workshop and radio laboratory I have all forms of knobs, switches, tools, telephone condensers, and all the "beloved junk" dear to the heart of every dyed-in-the-wool Amateur.—Jerome Sackheim, 516 West 74th St., New York City, N. Y.

Science in Slang

By EMERSON EASTERLING

THE x-ray is no longer an X, that is, an unknown," remarked Jazz the other day. "At least, we think that we have the dope on it. The lack of disproving evidence on our hypothesis of the penetrating beam renders our conjecture legally, at least, O. K."

"I can jerk the liver out of an automobile or a motorcycle and do my profession justice by sticking the thing back where it belongs—and the thing will rattle along like it had never even had liver trouble," put in Harry Smith, with a shrug of his shoulders. "But I don't seem to have the workings of this x-ray business under my katy. Is it anything like ignition?"

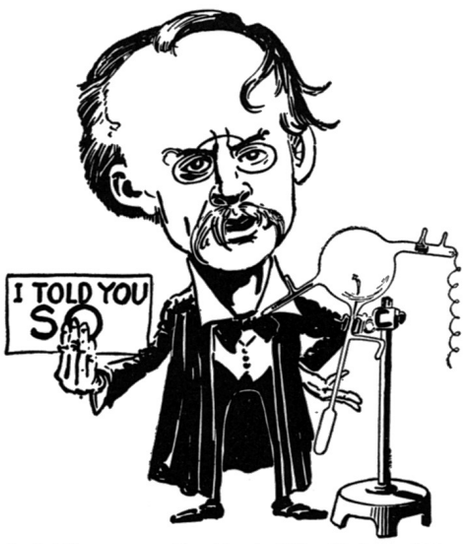
"Yes," returned Stokes, "it is in this respect: To produce x-rays, the guy who is going to do the stunt has to have a static machine or a spark coil to produce the little string of fire that plays between the anode and cathode in the bulb, and also plays the role part of the stunt.

"The dope goes like this: An almost exhausted tube or bulb has in it two terminals—the anode, or positive point or pole, and the cathode, or negative, same thing. The discharge shoots from the anode to the cathode. This action sets up certain vibrations, or rather a stream of infinitesimal hunks of electrically charged particles of something—almost nothing—waltzing along at the rate of 40,000 miles per second. (One speed ahead, and no reverse. However, that one speed varies.)

"Now the idea is that if these particles are brought to rest all of a sudden by an impact on a solid wall, there will be necessarily an immense change in the electrical and magnetic properties of the ether at the point where one of the particles of the cathode rays strikes the reason for all this sudden termination of the cathodic journey. At this point the disturbance will send a pulse into the ether.

Mr. Signor Herr Röntgen, the Cuckoo Who Pulled the X-Ray Out of the Pile of Unknowns.

Getting Down to the Bone



J. J. Thompson, the Duck Who Put Us Wise to the Dope That X-Rays Ionize the Air.

"So you see the real x-ray is not sent off the cathode terminal but off the platinum plate that is put up to catch all of the stream of almost nothing that flies off the negative pole. Röntgen, the bird that pulled the x-ray out of the pile of unknowns, found out that the vibrations that are known as the cathodic rays were not kicked off the cathode itself, but reflected from points of the tube, so he inserted the platinum plate.

"The way it all came about was this way: A guy by the name of Sir Bill Crookes, an English physicist (not medically speaking) who was at that time an authority on sanitation and sewage problems, unloaded most of the atmosphere from a tube—and right there was born the Crookes Tube. Even to-day—historically, of course—we read of his methods of obtaining high or extreme vacua.

"Then in 1895 Rönty fools around with a pile of stuff that people thought he had no business with and handed us the ray that bears his name. Then Prof. J. J. Thompson of Cambridge, England, figured out that our whiskered friend did not have all the dope in the new stuff, so he sits in and shows his hand to the effect that besides showing up the internal man—that is, laying a guy open for inspection—that the rays would cause electrified bodies to lose their charge. It was discovered that both + & — charged bodies showed a test of 0 in potential after being in the proximity of an x-ray machine. J. J. wrinkled his brow and then lifted his forefinger and spake as follows: 'Gentlemen of the jury, etc. We (that is, I) have arrived at the verdict that our defendant, Mr. X Ray Beam, is charged guilty (that would indicate a positive charge, but the fact of the matter is that neither polarity is indicated) of causing dissuasion among the elements of the very air. The gases themselves are divided into positive and negative electrifications. Components are reduced to opponents. It is almost shocking!' From then on we were on to the fact that x-rays ionized the air.

"Old J. J. started something. He lifted the lid for a lot of scientific researches that have put us wise to a gob of things that we would probably have been ignorant of had not the old boy reasoned in the manner that he did, and arrived at the conclusions that he pulled up at.

"The old ducks have it down in their note-books that the funny rays are not subject to reflection, refraction, defraction, interference or polarization. The rays pass in straight lines through anything that does not absorb them. They are not due to trains of waves, otherwise they would be made to defract and experience interference.

"The nice part of it in the surgical profession is that the density of the object that the ray is trying to penetrate is the only thing that hinders the penetration. By study, the photographer—the rays effect the photographic plate, like actinic rays—can determine the internal structure of bodies with great certainty.

"The fluorescent action that x-rays have on certain substances render it possible for the operator to see the bones of your head without resorting to the photographic procedure. Certain substances modify the rays and render them visible—not in the real sense of the word, but produce shorter wave length vibrations that are perceptible to the human eye. The eye can detect waves that the photographic plate cannot, as red, the light that we use in our dark rooms, while the photographic plate records vibrations that are out of our reach the other way up the spectrum. With the mechanical eyes and our orbs we see a little better than did our predecessors, but even the scientists of to-day have hunches that there lies both ways a lot more vibrations that we are not cognizant of. In the invisible spectra some place the electric vibrations, x-rays, and other things that can only be explained by vibratory illustration. Some have all of them doped out as such-and-such a one wiggling at a certain rate per instant, and being in row A, B or C, etc., and some more, etc. They have sound stuck down in the other end of the spectrum, below dark light. I don't know where they have the icy stare classified—it must belong in the spectrum. It don't belong anywhere else."

"You said that the rays did not suffer reflection, or refraction," broke in Punk.

(*Continued on page 242*)

Sir Billy Crookes, Who Unloaded the Atmosphere from the Crookes Tube, and Right There Was Born the—Crookes Tube.

THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

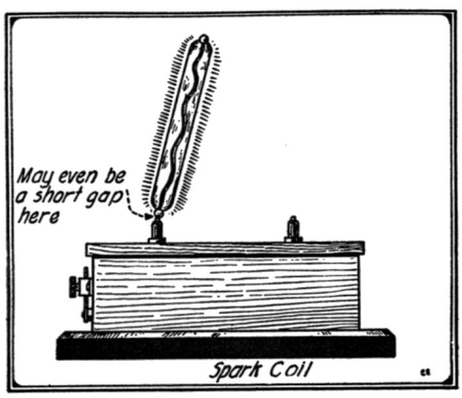
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

TESLA COIL AND GEISSLER TUBE HOOK-UPS.

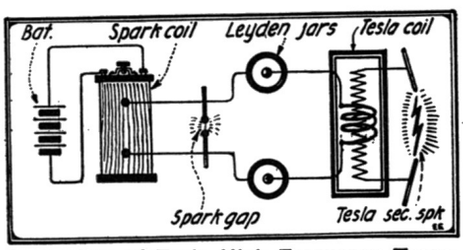
(1012) A. Terkel, Reedley, Cal., asks:

Q. 1. For a diagram of connections for Tesla coil, Geissler tubes, etc.

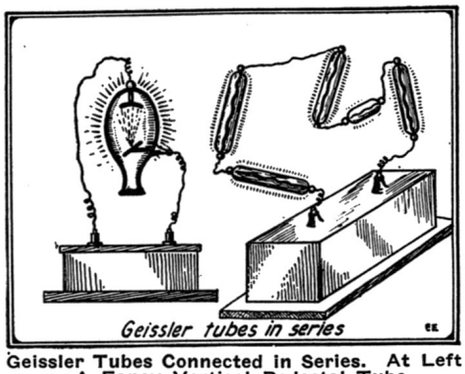
A. 1. We are pleased to give you herewith the diagram of connections for two inch spark coil, Tesla coil, Leyden jars, Geissler tubes, etc.



Lighting Geissler Tube from One Terminal of Spark Coil.



Connection of Tesla High Frequency Transformer, Leyden Jars, Spark Coil and Gap.



Geissler Tubes Connected in Series. At Left —A Fancy Vertical Pedestal Tube.

CHANGING SPEED AND VOLTAGE OF DYNAMO.

(1013) M—, Telephone System, Michigan, writes:

Q. 1. We have a 240-volt, 12.5-ampere, 4-pole, 1,250 R.P.M. dynamo. The four high resistance windings were in series with each other and the complete resistance connected to each feed; also the fields have another low resistance winding which carries all of the current going to the main line. In other words, it is *compound wound.*

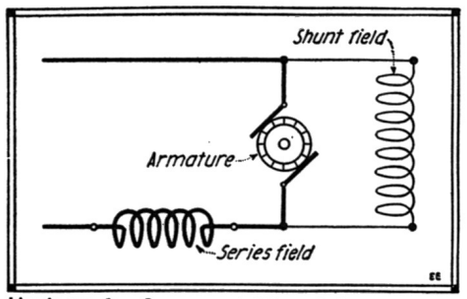
We have altered it by connecting the four high resistance field windings in multiple with each other and the armature, but have left the low resistance winding of the compound field unaltered.

We are using it at 40 volts, at which we seem to require to run it at 450 R.P.M.

Kindly state what the amperage, voltage and speed in R.P.M. should be when used thus, and if the dynamo is as efficient when so used.

A. 1. Considering that the dynamo when operated at 1,250 R.P.M. produces 240 volts, and that it has four field poles fitted with four shunt field coils, then, as is the case with practically all classes of dynamos, the voltage will vary directly with the speed, and if a dynamo is to be operated to produce 40 volts, then the speed should be approximately 1/6 of 1,250 R.P.M., or 208 R.P.M. For this voltage the four field coils should be connected in parallel, which would adapt them to operation at the reduced voltage, but the speed of the machine might have to be run up to between 300 and 400 R.P.M., owing to the fact that you could not obtain a sufficiently low resistance in your shunt field for 40-volt operation by connecting the four coils on parallel.

Originally, each of the four shunt field coils took 60 volts, and thus under ordinary conditions when you connect the four shunt field coils on parallel, you adapt them to operation on that potential, viz.: 60 volts, and not 40 volts. As these field coils will require, in accordance with Ohm's law, more than 40 volts, to force the necessary current thru them in order to produce the same number of ampere-turns and magnetic flux per pole, as becomes evident, it will be seen that the dynamo will have to be operated at a greater speed than 1/6 of the original value.



Hook-up for Compound Wound Dynamo Referred to in Rewinding Query No. 1013.

With regard to the amperage of the machine, this would be less than that in the original output, as there would be higher ohmic losses in the armature and field due to the reduced voltage, in proportion to those present when the machine was originally operated at the higher potential, or 240 volts. Roughly, the amperage would be probably about one-half of the original value.

The "August" Electrical Experimenter

"Bombs—How to Handle Them"—by Owen Eagan, Bomb Expert, Department of Combustibles, New York City Fire Department. A complete authoritative article with remarkable photographs by America's greatest expert on bombs and explosives, which tells you what to do should you receive a bomb by mail.

"A New Hydrostatic Wheel-less Railway"—by H. Gernsback. A Railway which has seen actual service. Without wheels it runs on a "film of water."

"Insanity from the Teeth?—What the X-Ray Shows"—by Dr. Henry A. Cotton.

"Electrical Refrigeration"—by Grace T. Hadley.

"Hot-Air and Other Engines"—by John J. Furia.

"Sir William Crookes' Researches on Psychical Phenomena" by Herewood Carrington, Ph.D.

"My Inventions" Part 6—by Dr. Nikola Tesla himself.

"Changing Nature's Face"—How Dynamite, plus Electricity, is used for clearing stump and rock-strewn property, blasting irrigating ditches, and changing the course of rivers.

"Experiments in Physics"—A new series. No. 1, perpetual motion, and popular fallacies concerning it exploded. By John J. Furia, Department of Physics, New York University.

"Loop Antennae"—An article of interest to all "Wireless Bugs." By Prof. Lloyd M. Knoll.

"Invention of the Crystal Detector" —by Greenleaf Whittier Pickard.

TESLA AND OUDIN COIL DATA.

(1014) E. W. Thatcher, Oberlin, Ohio, wants data:

Q. 1. For building Tesla and Oŭdin coils.

A. 1. We refer you to copy of this magazine wherein you will find the complete construction of a Tesla high frequency coil, also the Oŭdin coil. The article in question appeared in the May, 1917, issue of the ELECTRICAL EXPERIMENTER.

(*Continued on page* 242)

To Practical Men and Electrical Students

THE BURGESS BLUE BOOK is a pocket size note-book which was compiled especially for practical men, and those who are taking up the study of electricity. It contains drawings and diagrams of electrical machinery and connections, over two hundred formulas for calculations, and problems worked out showing how the formulas are used. This data is taken from my personal note-book, which was made while on different kinds of work, and it will be found of value to anyone engaged in the electrical business.

The drawings of connections for electrical apparatus include Motor Starters and Starting Boxes, Overload and Underload Release Boxes, Reversible Types, Elevator Controllers, Tank Controllers, Starters for Printing Press Motors, Automatic Controllers, Variable Field Type, Controllers for Mine Locomotives, Street Car Controllers, Connections for reversing Switches, Motor and Dynamo Rules and Rules for Speed Regulation. Also, Connections for Induction Motors and Starters, Delta and Star Connections and Connections for Auto Transformers, and Transformers for Lighting and Power Purposes. The drawings also show all kinds of lighting circuits, including special controls where Three and Four Way Switches are used.

The work on Calculations consists of Simple Electrical Mathematics, Electrical Units, Electrical Connections, Calculating Unknown Resistances, Calculation of Current in Branches of Parallel Circuits, How to Figure Weight of Wire, Wire Gauge Rules, Ohm's Law, Watt's Law, Information regarding Wire used for Electrical Purposes, Wire Calculations, Wiring Calculations, Illumination Calculations, Shunt Instruments and How to Calculate Resistance of Shunts, Power Calculations, Efficiency Calculations, Measuring Unknown Resistances, Dynamo and Dynamo Troubles, Motors and Motor Troubles, and Calculating Size of Pulleys.

Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

The "Burgess Blue Book" is published and sold by the Burgess Engineering Company for one dollar ($1.00) per copy, postpaid. If you wish one of the books, send me your order with a dollar bill, check or money order. I know the value of the book and can guarantee its satisfaction to you by returning your money, if you decide not to keep it after having had it for five days.

THIS BOOK IS RECOMMENDED BY PRACTICAL MEN.

It is surprising how much information, drawings, etc., can be concentrated into a pocket size book. These books should sell fast as when practical men who have any ambition to go ahead, wants one as soon as he sees it. I wish you every success, and will do my best to interest my brother workers in this work.
Yours truly,
J. J. Hanhauser, L. U. No. 98, I. B. E. W.

Received your BLUE BOOK, showed it to a friend, presto, I have no BLUE BOOK now. Enclosed find check for which please send me three more copies.
Yours very truly, E. F. Leisy, Tacoma, Washington.

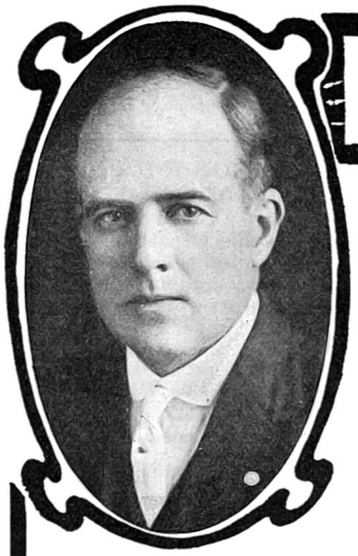
The concise form of the BURGESS BLUE BOOK should appeal to the men on the job. It is 100 per cent information.
J. L. Sleeper, Santa Ana, California.

Received your "BLUE BOOK" and must say it is the best book I ever saw. I showed it to a friend of mine and he refused to give it back to me, but he paid me a dollar and told me to get another. Rather than be without this book I am sending Money Order for three of them so I can show them to two more of my friends and have one left for myself. Wishing you would mail them at once, I am
Joseph Braith, Electrician, Madison, Wisconsin.

Your "BLUE BOOK" received and it is just the book I have been looking for. Please mail me three more by return mail for which I am enclosing Money Order.
Respectfully,
V. E. Johnson, Western Union Tel. Co., Marion, Ohio.

Have received the copy of the "BURGESS BLUE BOOK" and am very well pleased with the easily found formulas and data contained in it. I am enclosing Money Order for four additional copies.
Yours very truly, Thure C. Anderson, Ridgeway, Pa.

BURGESS ENGINEERING CO.
Yorke Burgess, *Consulting Engineer*
750 East 42nd Street Chicago, Illinois



ELECTRICITY

Taught By A Practical Man

And In Your Own Home

Put Part of Your Spare Time To A Good Purpose

A HOME STUDY COURSE FOR AMBITIOUS MEN

My Home Study course is actually an extension of a consulting engineering experience, which gives my students an opportunity of becoming familiar with electricity as applied to everyday work, and to understand how to manufacture, maintain, test, locate troubles and repair electrical apparatus and machinery.

MY PURPOSE

This course was designed and written by me with a view of reaching those who do not have a lot of time and money to devote to an electrical education. Some of my students are beginners, some have had a little experience, some have been in the game for years, but all are ambitious and trying to get ahead and realize that the SERVICE I am able to give is valuable and of such a nature that they have been unable to obtain it in any other way.

NOT A CUT AND DRIED BOOK PLAN

In addition to my practical and consulting experience, which covers a period of seventeen years, I have designed instruction courses for various educational institutions which has given me an unusual opportunity to study the teaching business from the standpoint of a practical man. I certainly would be a chump if I did not understand the situation and realize what was needed, after the opportunities I have had through which to learn what men need in order to make good in the electrical industry. For years, I made notes of small jobs, large jobs, and big installations, including maintaining, troubles, testing and repairing, and laying particular stress on the unusual things. This information is included in my regular lessons and anyone engaged in electrical work knows it is the kind of information he needs and wants.

BEGINNERS AND EXPERIENCED MEN

My course of study and SERVICE suit both beginners and experienced men, but they must have backbone and work with me as I work with them. This I insist on, as my SERVICE is my bread and butter and I will not waste it on one who will not be a credit to me. Anyone with an ordinary education and a good knowledge of the English language can successfully complete this work and make good in the electrical field, if he attends to business and follows my instructions. I do not tell you that I will fit you to qualify as an Electrical Engineer in a couple of months, because it cannot be done. Neither do I say you can earn fifty or one hundred dollars a week when you complete this work with me, as I, or any other man cannot correctly estimate the earning capacity of a student. How much you may earn depends on you as much as it does on me and my service. Many men I have taught are earning very large salaries and there are men who have doubled their earning capacity in a very short while, through my help, but how good *you* become, IS UP TO YOU. If you are in earnest, look into this proposition and send for my catalog, which tells the whole story in a plain, simple way, and in a way you cannot misunderstand and expect something you will not get.

RESULTS OF MY SERVICE

Practical Men Recommend My Course to Others.
My Students Are Invariably Promoted and Get Better Salaries.
Over 65 Percent of My Students are Engaged in the Electrical Business.
Over 11 Percent of My Present Enrollment was Obtained Through Satisfied Students.
Beginners are Able to Get Employment in Electrical Work After Taking My Course a Short While.

FIFTY-FIFTY

I work absolutely on a fifty-fifty basis with my students. You pay me the comparatively low price I ask and I give you the instruction and other help as detailed in my catalog. No student is permitted to pay for his course in full on starting, the payments being made in monthly installments. Students have the privilege of discontinuing the work if they find it is not just what they wish, and their payments stop at the same time. This is my way of doing business and a part of my fifty-fifty plan, as I do not want money from men whom I am not helping.

APPARATUS, INSTRUMENTS, MATERIAL, ETC.

Certain electrical apparatus, instruments, charts, drafting materials, etc., as described in the catalog, are included as a part of the course for which there is no extra charge as it is covered by the regular monthly payments.

Fill Out Coupon or

Write me and I shall promptly send you one of my catalogs which contains full information regarding my course and the service I offer.

Burgess Electrical School
745 East 42nd Street
Chicago, Illinois

YORKE BURGESS,
BURGESS ELECTRICAL SCHOOL,
745 East 42nd Street, Chicago, Illinois.

Gentlemen:—
Send me catalog describing your course in Electricity and Drafting.

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CITY .....

STATE .....

Health–Beauty–Power

Treat Yourself in Nature's Way

The Therapeutic White Rays of the Sterling Lamp are a scientific adaptation of the marvelous healing properties of the sun's rays. The warm, soothing, soft, white rays penetrate and vitalize every cell and tissue; new cell growth is stimulated; the body is refreshed and vitalized.

It brings you a clear, unblemished skin, rose-tinted cheeks, bright eyes; quickens the sluggish blood, rebuilds firm new muscle, and clear, new skin.

STERLING THERAPEUTIC LAMP

"The Light That Heals"

Relieves pain without destroying vitality. Absolutely safe; no vibration, shock or pain. Does away with use of harmful drugs. Relief from pain results the moment you snap the electric switch. Rheumatism, neuralgia, sore throat, earache, goitre, headache, nervous conditions, and innumerable other ailments, are instantly eased and relieved. Invaluable in the treatment of skin diseases. Physicians endorse and recommend Therapeutic Light to you.

Send Coupon for Free Book

Nothing vague or mystic in the Sterling Lamp. Our free book tells of its uses and many benefits—deals with the simple, fundamental laws of health and beauty. Tells you how to treat yourself at a few cents in cost, relieving you of pains and ailments and awakening your energy; how others in hospitals, sanitariums and thousands of private homes have benefited. Don't suffer headaches and other pains needlessly—let Nature and Science help you to health, beauty and greater vitality.

STERLING THERAPEUTIC LAMP CO.
Dept. 13, 546 Garfield Ave.
Chicago, Ill.

Use This Coupon

STERLING THERAPEUTIC LAMP CO.,
Dept. 13, 546 Garfield Ave., Chicago, Illinois.

Please send me, without cost or obligation, your fully illustrated booklet describing the Sterling Therapeutic Lamp, its uses and benefits.

Name .....

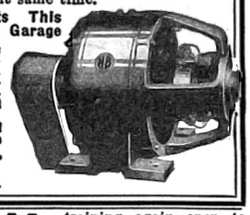
Street & No. .....

City .....State .....

Brilliant Lights and BIG PROFITS in BATTERY CHARGING with this HB LIGHTING and CHARGING SET

This sturdy, dependable outfit makes electric lights at lowest cost, and besides brings the BIG PROFITS that battery charging pays. Operates from your line shaft or engine. Trouble proof, economical, no wear-out. Charges auto batteries and furnishes electric light at same time.

Small Payment Puts This Money-Maker In Your Garage



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training again open to civilians. Over 3000 men trained for electrical industries in experience of more than a quarter of a century. For men of ambition and limited time. Condensed course in Electrical enables graduates to secure good positions and promotions. Theoretical and Practical Electricity, Mathematics, Steam and Gas Engines, Mechanical Drawing. Students construct dynamos, install wiring and test electrical machinery. Course with diploma, complete.

Thoroughly equipped fireproof dormitories, dining hall, laboratories, shops. Write for catalog. 27th year opens October 1, 1919.

BLISS ELECTRICAL SCHOOL
260 Takoma Avenue, Washington, D. C.

The Oracle

(*Continued from page* 240)

HOW AND WHY OF RADIO APPARATUS SERIES.

(1015) Salvador C. Bayani, Manila, Philippines, writes this Department:

Q. 1. For a list of the "How and Why of Radio Apparatus," and in which issues the various installments appeared.

A. 1. Below we give a list of these:

No. 1. *The Induction Coil, Page* 493, *November,* 1916.

No. 2. *The Transformer, Page* 656, *January,* 1917.

No. 3. *Condensers, Page* 735, *February,* 1917.

No. 4. *Spark Gaps, Page* 113, *June,* 1917.

No. 5. *Radio Transmitting Inductances, Page* 537, *December,* 1917.

No. 6. *Radio Receiving Tuners, Page* 685, *February,* 1918.

No. 7. *Radio Receiving Condensers, Page* 766, *March,* 1918.

No. 8. *Detectors, Page* 30, *May,* 1918.

No. 9. *Telephone Receivers, Page* 176, *July,* 1918.

Radio men everywhere will undoubtedly like to obtain the complete set of these specially prepared papers on the "How and Why of Radio Apparatus." Also the following three important and timely papers on the "Calculation and Measurement of Inductance," by Secor and Cohen.

Nos. 1, 2 *and* 3 *"Calculation and Measurement of Inductance," appearing in the March, April and September,* 1917, *issues.*

Those interested in these valuable papers can obtain prices of individual back numbers containing them by writing to the "Circulation Department."

SCIENCE IN SLANG.

(*Continued from page* 239)

"But your explanation of the etheric disturbance against the wall seems to me that the etheric vibrations disturbing the ether in the place where it came in contact with an object would send pulses into the air that would be equivalent to reflection or refraction. You know what I mean, don't you? I can't explain it exactly."

"Yes," replied Jazz, "I believe I do. If the stream of cathodic rays were regular that condition would be possible, but for the fact that they are not regular I don't see but why they would not myself. Then, too, the etheric vibrations would not effect like the cathodic discharges.

"However, there is a condition that was explained by J. J. and a bird with my name, but no relation of mine, of Cambridge, and Prof. Lehmann, of Karlsruhe, and seems not such bad dope. They all bounced up with the conclusion that bodies that absorb x-rays have power to create other rays likened to the x-rays to such an extent that the old static machine could not tell them apart—if there was any diff at all. They called it 'secondary radiation'—but, for that matter, the x-ray is that.

"What made them get onto that stuff was that they found indications of their 'luminiferous ether' behind objects that absorbed all the light, and if the rays were not reflected or refracted how in the —— did they get there? Stokes (no relation of mine) figured it out mathematically that such pulses, or extremely short disturbances of ether would act in that way and be acted upon in that way."

"What all do the doctors tell with the x-ray?" asked Bender.

"Well," began Jazz, with a smile, "they are able to detect the presence and the extent of tuberculosis, pneumonia, pleurisy, hydrothorax, emphysema, empyema, and other such disorders and ailments——"

"Yes, and water on the brain, lovesickness and obesity," added Punk.

Advertising Talks

NUMBER 4

LAST month, I showed you how advertising made a firm spending many thousands of dollars a month keep up the high quality of its goods or whatever it has to sell. I gave you good proof of how every dollar advertisers spent in the ELECTRICAL EXPERIMENTER was your assurance that what you bought from them must be up to the standard so that the advertiser might hold your trade and stay in business.

Naturally the thought comes "who pays for this advertising? Can the advertiser really pay out a small fortune each month without going 'broke,' or does he add a certain percentage to the price of his product to pay for the advertising, and do I in the long run really pay his advertising bills?" **No, indeed, far from it.** True it is that the advertiser must get back in profits what he spends for every expense connected with his business. But nevertheless you really save money by dealing with advertisers as you can readily understand by studying the matter carefully for a few minutes.

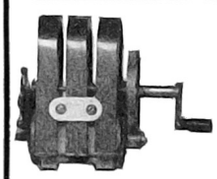
It stands to reason that the more business a concern does, the cheaper it can conduct its affairs. The small firm handling only a few orders each day and trusting to luck that customers will find their way to its doors, must make a fairly big profit on each transaction. The live, up-to-date firm, doing a business all over the country (and sometimes the world, if it advertises in the "Experimenter") systematizes its operations so thoroughly and with the use of the latest and best machinery, can turn out better products at a lower cost than its slow, unprogressive competitor. The larger the production of any one article, the lower the cost of manufacture of each individual piece, as any keen business man will tell you. Furthermore, with a large volume of orders a firm can afford to make a very small profit on each order and still, in the long run, make as much profit as the non-advertiser. And then, as an attractively low price (quality considered) is necessary to get and hold your trade and so make their advertising really effective, all far-sighted advertisers are in the habit of marketing their goods at the smallest profit they can successfully do business on, relying on a big volume of orders to keep going.

So you see that not only can an advertiser make what he sells more cheaply, but he can run his business at less expense, and he can afford to cut his profit on each order to a very small figure. This means that you get what you order from an advertiser at a cheaper price than possible elsewhere, and yet the advertiser makes enough profit *by advertising* to pay his advertising bills.

Advertising Manager.

EXPERIMENTERS!

Read every word on this page. Note the wonderful goods we are offering at rock-bottom prices. Read the details of our offer of $10.00. Don't miss anything or you will lose money.



High grade telephone magnetos—guaranteed quality; strong and substantial; output 80 to 110 volts A. C. 4 bar, 8 lbs.....$2.25
3 bar, 7 lbs.... **1.75**

Telephone ringers, or bells, of same type sold to telephone companies all over world. Perfect shape. With gongs—1000 ohm (like cut), 1 lb. $1.25
1000 ohm other styles, 1 lb.. .75
80 ohm, 1 lb. .... **.50**

Fixed telephone condensers. All capacities from ½ to 2 M.F. Tin foil and rice paper. Excellent condition.
2 M.F., 2 lbs. $.60
1 M.F., 1 lb. .50
½ M.F., 1 lb..... **.40**

Telephone Switchboard, keys or switches. German silver springs. Two switches mounted on one escutcheon. A wonderful and useful addition to your laboratory. 1 lb. .. **1.50**

Watch case receivers, double pole permanent magnet 75 ohms. composition shell. Very handy for experimenting and wireless, 12 oz. $1.25
Single pole, like cut, metal shell, very sensitive. 12 oz. **1.00**

High grade telephone receivers used on all telephones. Very sensitive. With cord, New. $1.25
Other styles 1 lb. 1.00
Stromberg-Carlson fool proof metal type. 1 lb. .. **.80**

Headband receivers, with long cord attached. 75 ohms. Very good for wireless. Extremely sensitive and more handy than plain watch case. 1 lb. .. **1.75**

Sensitive transmitters and arms complete as shown with Skinderviken transmitter button. 2 lbs. $1.75
A very convenient mounting for a transmitter. Adjustable. With other make transmitters, 2 lbs. **1.50**

Local battery or magneto induction coils provide a very desirable instrument. Make fine medical coils. Steps up sound in telephone. A cheap but effective amplifier, 6 oz. ..... **.40**

When ordering any of the equipment shown here, be sure to remit enough for postage. Any excess will be refunded. All apparatus is guaranteed high grade commercial type the same as supplied to largest telephone companies all over the country.

Here is a low priced commercial telegraph key. Strong and substantial, neat in appearance. Excellent contact points and bearings. Works very easily, with just the right touch. Adjustable springs. 1 lb. **1.25**

A large neat sounder, with a sharp "click." Aluminum lever, solid brass base, 20 ohm rubber covered magnets, large adjusting nuts, mahogany base and large binding posts. 1½ lbs. A bargain at..... **2.00**

Want Ten Dollars?

SINCE we began advertising the SKINDERVIKEN TRANSMITTER BUTTON about six months ago, we have supplied thousands to experimenters not only in this country, but in Canada, Australia, Europe and South America.

It is interesting to note the various uses to which these Buttons will be applied. The question is—"What are you doing with your button?" We would like to know, as there are thousands of other experimenters who would like to use it for the same purpose.

We will make it worth your while to submit your ideas. We are going to pay $10.00 cash for the best idea. All others, accepted by us, will be paid for in proportion. Now then, get busy, you fellows.

Any idea you may have of using a SKINDERVIKEN TRANSMITTER BUTTON will be all right. However, try to make it original.

Actual size

THE SKINDERVIKEN TRANSMITTER BUTTON is an improved compact microphone. It is extremely sensitive, easily adaptable to telephones, detectiphones, deaf phones, radio telephones and electrical experimenting. We have received dozens of letters from experimenters telling us of "its wonderful work." We furnish a booklet of instructions and diagrams for experimenting, also with outlines of suggested experiments.

We know from experience that you will find the Button a very interesting piece of apparatus. It is so very sensitive and it only needs one dry cell for its operation. Lots of fun can be had from its use.

Skinderviken Telephone Equipment Co.

2134-2136 No. Clark Street, Chicago
335 Broadway, New York

USE THIS COUPON

STECO E. E. 7-19

I enclose $.... for which please send me the following:

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Signed .....*Address* .....

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Enters the Electrical Field as a High-Salaried, Industrial Specialist.

If you desire to qualify as a Power Plant Superintendent, Electrical Draftsman, City Technician, or Supervisor of Electrical Equipment Maintenance—

Study Electrotechnics:

The time to start is right **now,**—when the field is unlimited—uncrowded. Industrial organizations everywhere are demanding the services of trained Electrotechnicians.

At This School Only

can you prepare especially for the field by taking the special, condensed course in Electrotechnics. The system of combined work-shop, laboratory, drafting and recitation room instruction quickly and thoroughly equip you to assume positions of importance in the industrial world.

Open to all Grammar School graduates. High School or College work credited to give you advanced standing, enabling you to shorten course from 6 to 18 months

"Earn While You Learn" if you like.

New Term Opens July 2d.

There's no time for delay if you wish a place reserved for you. Clip the coupon **NOW** for catalog and full particulars. It may mean your start on a new career.

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Gentlemen:—Without obligation, send me catalog and full particulars regarding the Electrotechnician Course.

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95-373 Broadway Milwaukee, Wis.

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Build and Fly Your Own Training Plane

Train yourself in Aviation. Be an Amateur Aviator with an Aeroplane of your own. Learn how Aeroplanes are built; learn the principles of construction, operation and control. We sell IDEAL Accurate Scale Drawings, and Building and Flying Instructions which show you how to build a perfect Model Aeroplane, 3 ft. size, that will rise from the ground by its own power and fly like a big one. Send now for the Drawings and Instructions for the one you want to build.

Drawings and Instructions for
Curtiss Military Tractor
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25c EACH
Set of Seven $1.50 postpaid

Ideal Model Aeroplane Catalog 5c—None Free

Tells about Model Aeroplanes, Racing Aeroplanes, Flying Toys, and parts and supplies to build them with. 48 pages. Sent only upon receipt of 5 cents.

IDEAL AIRPLANE & SUPPLY COMPANY
159-161 Wooster St., New York City

Be a Mining Engineer

A great profession, not overcrowded, offers the diligent and ambitious student assured and exceptional rewards. *Located in the heart of one of the greatest copper mining districts in the world,* the College offers a unique combination of theoretical instruction with practical experience in all phases of mine development and operation. Four year course can be completed in three. Vast mines, mills, smelters, electrolytic and power plants of the most modern type, are practically a part of the College equipment and constitute a factor of enormous value in the courses of instruction. Every opportunity for specialization. A state supported college not conducted for profit. Established 1886. "M. C. M. Men Make Good." For descriptive book address Administrative Officer, Houghton, Michigan.

Michigan College of Mines

A Dash to the Clouds

(*Continued from page* 206)

cars themselves are spanned with large wings, measuring eighteen feet from tip to tip. In addition to this spectacle, several other new features are being added to the great list of amusements for the public during the season. Principal among these is the "Witching Waves," a delightful ride in the imitation of an ocean trip. An added feature is a new pony track for those who like the hobby horses. Another novel innovation will be the "U-Boat Dodger," being a ride in a small submarine boat carrying passengers and chasing another submarine. The "Tub Race" is also a new novelty. In addition there will be a new gigantic "Roller Coaster" with a 3,000-foot ride with eight of the biggest dips ever constructed, which will be equal to some of the nose dives now made famous in plane flying. This new roller coaster will cost about $25,000. The "Canals of Venice" is another interesting attraction; cost of construction, $5,000. A very interesting addition to the Park will be a large scale model of a coal mine, showing a cross-section down thru the entire region, also the street above. Here small figures automatically will go thru hundreds and hundreds of different moves, people on the street hurrying back and forth from stores to their homes, trolley cars in action, automobiles, shaft elevators in the coal mine, running up and down with men, little coal cars will go back and forth with their loads and rise to the surface and every little intricate detail of coal mining operation will be faithfully reproduced in this miniature model.

The building which was devoted last year to foreign buyers' markets and interesting collections from the world over has been turned into a skating rink this season, due to the fact that the unforeseen circumstances of the war made it impossible to get sufficient exhibits from foreign countries to run the exhibition hall this season. It is to be hoped that within the next twelve months or so conditions will have so settled themselves that by next year there may be many interesting trophies from the fields of battle. As it is, this giant roller rink can accommodate hundreds of people. Fancy skaters, those who can't skate so well or not at all, with the aid of the big band and cheery music will forget their little bumps and keep smilingly on.

Perhaps the greatest feature of all amusement resorts, fairs, parks and expositions, is the tremendous amount of electrical equipment necessary to keep all these things in motion, and which is seldom realized by the visiting public. Hundreds of horsepower are consumed hourly by these amusement devices. The power is taken directly from the New York Central Railroad, which passes the grounds, and this power at 660 volts is brought into specially constructed damp-proof vaults, where four 100 K.V.A. large oil transformers shoot the juice to all parts of the grounds. In addition there are several smaller transformers, for special purposes supplying different sections. In this case a tremendous amount of money was saved by installing the 660-volt system to every part of the grounds. These cables are carried thru underground conduits and manholes to points where the power is needed, and there the power is transformed to 220 and 110 volts. The saving in cable alone amounts to thousands of dollars, as by using 660 volts a cable approximately one-third the size is required. This gigantic system of transformers, switches, underground cables, man-holes, etc., has cost $100,000.

An immense fire alarm system has been installed to cover the entire grounds. Should a fire occur at any point, simply the pulling of a hook in a box will cause a large bell centrally located in the park to strike a certain signal, which will indicate to all the employes the location of the fire.

Also, as last year, we have the wonderful bathing pool, with its artificial waves, probably the largest in the world, where hundreds may daily disport themselves in its waters, not forgetting the kiddies with their sand pails and shovels, the big band stand with its towering jewels and sympathetic music.

The Oyster's Autograph

(*Continued from page* 207)

sumption of oysters that have drunk in disease germs in the plumping process.

The trick as carried on by the oyster dealer or grower is that he takes the oysters from their natural depths where they mature, and places them in coves and harbors where fresh water streams terminate. Being less saline, the water is less dense, and hence there is an interchange of the fluids thru the walls of the bivalve. When the oyster opens his shell for feeding or for any purposes, the tissues swell. The oysters are not placed in absolutely fresh water, for this would kill them, but in water somewhat fresher than that where they are grown.

The nutritive value which is lost in this process is quite marked. The fluids which are past out from the tissues of the oyster carry with them salts and some fats, chemical experiments showing that the oyster, tho larger after plumping, has lost 13 per cent. of its original nutritious substance, proteins, fats, carbohydrates and mineral salts. This has been found to be true by experiments conducted by Dr. H. F. Moore, of the U. S. Bureau of Fisheries. He states that with the loss of these fluids passing out from the oyster, sufficient water will have been taken up, however, to increase the total weight of the oyster from 12 to 20 per cent. Therefore, it can be seen that what the oyster has really gained is simply water, which is of no food-giving value at all.

Altho scientists are at a loss to agree upon the precise food that oysters eat, whether the beautiful diatom, a vegetable organism, or other microscopic animalcules, it has been found that in experiments recently conducted oysters planted in the sewage-laden waters of Jamaica Bay, near New York, that the oysters can become marketable after a period of eighteen months. Whereas, normally it takes three years before oysters are of sufficient size for the table. Cutting the growing period in half indicates that oysters are not exclusively partial to the natural foods of the water, but, on the contrary, they have an especial fondness for the city's sewage disposal. When Dr. Nelson finishes his experiments, he will furnish the U. S. Bureau of Fisheries, with whom he is coöperating, a constructive program on the general improvement in the culture of this important food. One of the most important phases of his investigation will be that of studying carefully the relation between environment and propagation. Authorities estimate that a single oyster spawns from sixteen million to sixty million eggs in a year, but not-

withstanding this enormous fecundity of the individual oyster, the propagative power of the beds is not so vast as might be supposed. The oysters may be planted on the bottom, especially prepared by clearing it of all refuse material, and a bed so formed of good clean gravel and shells, in order that the young "spat" will have some object to cling to, as otherwise, in a muddy bottom, they would soon be covered over. Yet with many of these precautions some beds will prove greatly fruitful, whereas others prepared in the same way and in adjacent waters result with very poor crops. Certain locations in various waters are particularly abundant in diatoms, the minute organisms on which the oyster is supposed to feed. Yet it is not the generally accepted fact that the diatom is the main article of the oyster's diet, as can be evinced by the quick growth of the oysters in waters polluted with sewage. Generally speaking it is to be hoped that when Professor Nelson finishes his experiments he will have such an array of data and abundance of far-reaching discoveries that thru artificial feeding and environment a variety of oyster may be produced that will excel any heretofore sold on the market and in addition to its phenomenal size it will be healthful and free from all disease germs. It probably will be possible thru Dr. Nelson's researches on the culture of the bivalve to produce such a type as will rank with the discoveries of Burbank's wonderful achievements in producing new and better varieties of fruits and vegetables. —*Photos Courtesy Star Company.*

Flying Across the Atlantic

By H. Winfield Secor

(*Continued from page* 214)

and increase the speed of the machine about 10 miles per hour. The illustration, A, shows some of these points on Lieut. Hawker's ill-fated 'plane, and among other considerations we would mention the following: Only one engine was used, a Rolls-Royce 375 H.P. airplane engine—and very few aviators would care to start off on such a trip with a single engine where continuous flying may have to be kept up from 22 to 28 hours. If the slightest thing goes wrong with this engine and it stops, it may spell disaster, or at least the failure to make the trip in nonstop form. Lieut. Hawker counted on saving himself if obliged to land in the water by the fact that the fuselage of his 'plane was made water-tight, and he also counted on the buoyancy of the gasoline tank as well as a life-saving suit which he wore. But the ocean is known only to those who have crost it and seen the waves roll up forty feet high. The weather was very uncertain, and a storm was said to be blowing up in mid-ocean when he started from New Foundland.

Among other weak points in this type of 'plane, we find that no pontoons were used, thus giving small chance of the 'plane staying afloat, at least for any length of time beyond a few hours. Also the 'plane was very small and frail. Added to this, we have the almost incomprehensible difficulty of navigating such a long flight over an uncharted course. The aviator would have to fly thru the night and rely only on a compass and a sextant to guide him by the help of the stars, if the clouds did not obscure them. But no pilot vessels or chart marks such as buoys, not even radio compass signal directions, were provided or arranged for. It would seem nothing short of superhuman, under these conditions, for the two intrepid fliers to ever reach the far distant coast of Ireland, as they had hoped to.

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Superiority of the Seaplane.

Fig. B shows the second type of aircraft which has been tried and tested with great success by the U. S. naval flying men for trans-Atlantic work. Not only are these 'planes fitted with large roomy pontoons which are about the size of the usual unsinkable life-boat found at all coast guard stations along the seaboard, but the 'planes have been designed with every possible engineering consideration in mind, particularly any failure of the engine plant. It should always be possible, or let us say feasible, especially when small 'planes are to be used for such trans-Atlantic or trans-Pacific travel, to provide them with an engine plant consisting of more than one engine. But there is no doubt about it that for any form of heavier-than-air machine, such as sea- or airplanes, more than one engine should be installed. With some of the twin-engined biplanes used several years ago it was found possible to keep the 'plane airworthy, and flying on one engine when the other engine, for any reason, failed. The same logic applies to the Navy-Curtiss seaplanes, or "N C" 'planes, as they are familiarly called. Four 400 H. P. Liberty engines are fitted on each seaplane, and if one of these engines should fail, three would be left to maintain the 'plane in the air. However, at least three engines are normally required to keep these heavy ships in the air, as seaplanes are much heavier than land-type 'planes, size for size; the "N C" 'planes weighing with load about 28,500 pounds when they took the big "hop-off" for Europe.

Thus far we see that the Navy's flying boats have two great advantages which should not be overlooked in designing any machine intended for trans-oceanic flight, and among other features which were made available for the flight of the three 'planes on their history-making journey across the broad Atlantic we find the following: Radio-telephone apparatus operating from 'plane to shore or ship stations, and between other 'planes, with a range of 30 to 40 miles; also radio-telegraph apparatus capable of transmitting and receiving up to 150 miles. A new record was made in airplane radio transmission during the seaward flight of the "N C" 'planes, when an unrelayed message was picked up from the NC-4 at a distance of 400 miles, at the Otter Cliffs radio station in Maine. Not only was the regular radio communication made available at every turn, but the U. S. Government exercised special precautions to render certain that the aviators, in case they should have to descend on the ocean, should not lose their lives unnecessarily. It placed warships, including cruisers and destroyers, in a complete chain from the American coast to the Azores, as well as from the Azores to Lisbon, Portugal, the official terminating point of the trans-Atlantic flight by the seaplanes. These vessels were placed about 75 miles apart and closer together in the regions where night flying occurred.

The vessels along the route could communicate by wireless with the 'planes and get their bearings, weather conditions, etc., from the ships of the air as they sped along overhead. At night the war vessels used their searchlights and were otherwise marked with electric signal lamps. On the decks appeared the ship's station number in electric lights, so that the 'planes could see at a glance as they flew ahead just what position on the route they were at. Provision was also made for receiving directive radio compass signals. These considerations and provisions would perhaps seem overdrawn or overimportant to the lay reader, but each and every one of them represents a fine piece of applied engineering and they comprise elements of technique which were not picked out at the eleventh hour and simply slapt on the 'planes, but all of these points were under constant consideration, and in the hands of competent Navy engineers and experts for over two years. By comparison it is seen that no expense of money and brains was spared to make this trip successful—at least, if not successful, "safe" so far as humanly possible. This plan was carried out, thanks to the U. S. Government, to the extent of costing $1,000,000 before the gigantic naval 'planes "hopped off" at Trepassey Bay, on Friday, May 16, in an attempt to cross the Atlantic Ocean thru the air for the first time in history.

The Dirigible.

The illustration Fig. C shows a probable development of trans-Atlantic aircraft which has been mentioned frequently in connection with trans-oceanic travel *via* the air—i. e. the *dirigible*, or gas balloon. The U. S. Naval dirigible C-5 made one of the most beautiful non-stop aërial flights in history, when it covered the distance between Rockaway Beach, near New York City, to St. Johns, New Foundland, a distance of over 1,000 miles, in 26 hours, flying continuously night and day. The naval authorities have announced that they hoped to have another dirigible airship ready shortly to attempt the trans-Atlantic flight. England is hoping to startle the inhabitants of New York City some bright and early summer morning by a visit of one of her 5,000,000 cubic foot, giant dirigibles. With fair weather conditions, it would seem that the modern dirigible, when given a fair chance, will prove a powerful competitor of the seaplane for crossing the ocean. However, the gas balloon possesses, along with some of its advantages, a number of marked disadvantages, and we shall now consider them.

Among the advantages of the gas balloon "lighter-than-air" type of airship, especially when considering long distance flights of 1,000 to 2,000 miles or more, over water, as in crossing the ocean, we are imprest by one predominant fact, and that is that, no matter if the engines all come to a stop on the dirigible, she will still retain her buoyancy in the air and the crew is safe as long as it remains afloat in the air. Under such circumstances there are two major things which may and can happen: first, the winds would blow the balloon along at a fairly high speed and usually the crew is safe in the air and not resting on the waves. The latter, when the sea is rough, often rise to heights of 30 to 40 feet or more, and if the engines or necessary apparatus cannot be repaired, then the dirigible can hail or radio a steamer, and the crew taken off. This could be accomplisht by means of a rope ladder, as has been successfully tried by the U. S. Navy off the coast of Florida, as described in the article on page 108 of the June issue. Secondly, while the dirigible had her engines stopt, the mechanics would be endeavoring to repair them and get them in working order again. The speed of the new type of dirigible such as used by the U. S. Navy, is fairly high, viz: 50 to 60 miles an hour, and these airships have great lifting power, so that they present a very logical answer to the aërial passenger ship requirements of the future. Another advantage which they possess, and due primarily to their great lifting power and buoyancy, is their long range of operations—it being possible for them to take on board sufficient engine fuel to accomplish trips of several thousand miles. Another advantage of such an airship is that, if the engines suddenly stop, the steering gear can be maneuvered and other arrangements made whereby she can be brought to earth gently and in good order; contrary to the usual tactics when the engine of the ordinary airplane stops, which has caused many accidents, owing to the sudden loss of buoyancy of the 'plane and the rapid dive earthward, which may or may not end disastrously.

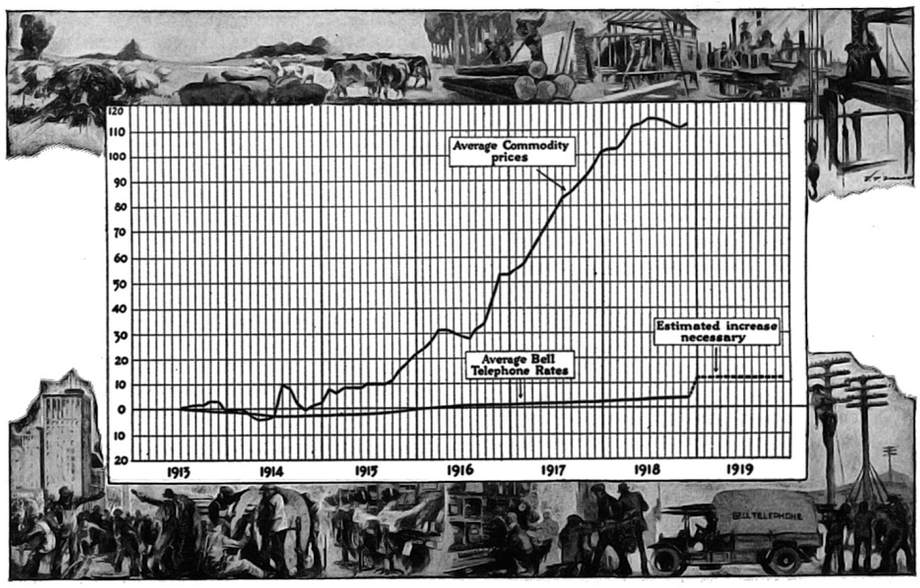
The disadvantages of the dirigible are several, and among the first and foremost we are forced face to face with the fact that they are distinctly difficult to manage and maneuver in stormy weather or high winds. It will probably take some years for our aëronautical engineers to devise means, such as by sub-dividing the gas bag of the dirigible, or by other design tactics, so that the great resistance now offered to the wind will be circumnavigated. If you have ever been up in a "blimp," such as the observation balloons used extensively during the war are called, then you will be in a position to know just what these dirigibles are up against with a heavy wind blowing against them. Even if you are up in a blimp about a thousand feet above the earth, on such a trip as the writer has in mind and which took place at Rockaway Beach about a year ago, you will be surprised, and not altogether pleasantly either, when on a clear day, with the giant gas bag floating lazily in the air, you almost have your feet fly up and shake hands with your face, for all of a sudden—woof!!! Old Mr. Blimp jumps diagonally—or was it vertically?—about fifty feet! No, fellow scientists, it was not magnetic or electrostatic attraction for another blimp which you perceive about one-half mile away, but simply the *irresistible force of the wind* exercising its full wallop against the vast hulking form of the blimp "gas bag."

Therefore, not only is the dirigible a tricky machine in high winds or storms, as was experienced countless times by Count Zeppelin, the erstwhile investigator of Zeppelin tactics when his giant cigar-shaped dirigibles 600 to 800 feet in length were destroyed one after another in storms, but they also have the disadvantage of *slower speed* as compared to the seaplanes, owing primarily to the greater bulk of the gas container or bag which has to be driven thru the air with a consequent great displacement thereof. When it comes to a forced landing on the sea, most aviators would undoubtedly rather take their chances with a seaplane of the Navy type, rather than with a dirigible of any size. For they may, if the weather is quite calm, land in a detachable life-boat carried by the dirigible and by means of a rope ladder descend into it while on the surface of the ocean. This, with the chances under ordinary conditions that they would have to make an attempt at lowering the altitude of the dirigible herself. In this case they would remain in the gondola attached underneath the dirigible, with the possibility that the "elephant of the air" would attempt to set down on them and smother them. At any rate it would require extremely skillful seamanship to carry out such a maneuver successfully. The question of fire in dirigibles has been made practically obsolete, in view of the fact that the U. S. War Department in the past few years has developed the new balloon gas "helium" to the stage where it is available at small cost, and this new gas is absolutely non-inflammable. Its lifting power is 85 per cent of that of hydrogen, the gas heretofore used in blimps and dirigibles, but which possesses the disadvantage of being inflammable.

Radio Equipment of the NC Seaplanes.

Details of the radio installation of the NC seaplanes engaged in the attempt to make the transatlantic flight, as given out by Acting Secretary Roosevelt of the Navy Department, follows:

The radio on the NC seaplanes involves two transmitters. One is a ½ K. W. spark transmitter, the main element of which is a streamline generator and accessory apparatus, which is driven by an air propeller and is mounted on the deck of the boat aft. This set weighs only forty-five pounds, but is used for the regular telegraph communications between the seaplanes and stations up to a distance of 250 nautical miles. Since this set is driven by a



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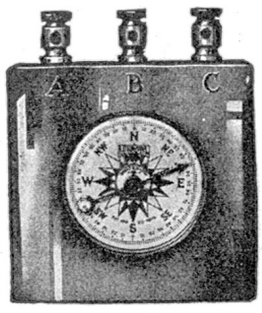

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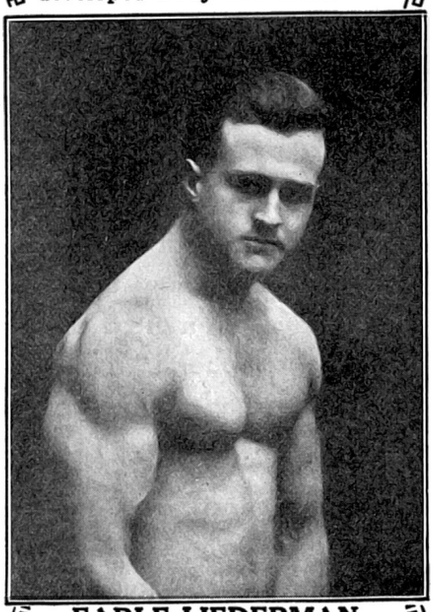

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propeller, it can only be used while seaplanes are in flight. The antenna used for this set is a single trailing wire leading from the tail of the boat for a distance of 250 feet down and to the rear. A streamline lead weight holds the lower end of this wire down.

With this transmitter it is possible for the commanding officer to send messages from time to time regarding the progress of the flight, to be retransmitted by the nearest shore station to the Navy Department. Also communication can be held with destroyers or other craft and radio compass signals or other information requested.

The other transmitter is a combined telephone and telegraph transmitter, and operates on a small 12-volt storage battery. It is used on an antenna consisting of wires permanently stretched on the skid fins on the upper planes so that it may be used while the seaplane is in flight or on the water.

The Anti-Noise Microphone.

It is this set which is used for telephoning between the 'planes, arrangement being made so that either the radio operators or the commanding officers themselves may communicate directly by telephone while the 'planes are in flight. Such interplane telephoning may be carried on up to a distance of twenty miles. While on the water this set may be used for telegraphing or telephoning a distance of about thirty miles.

A special feature of the telephone sets is the *anti-noise microphone,* which is so constructed that the engine noises are not heard. This is accomplisht by having the back of the microphone open. The exterior sound waves strike the back as hard as the face of the diafram, and therefore the effect is neutral. The voice waves strike only the face of the diafram, and even tho the operator cannot hear his own voice, the radio sets receive enough effect to modulate the transmitted wave.

This single item has been the deciding factor in success or failure in long-distance transmission by telephone by airplane. It is easy enough for short distances to get communication with an ordinary microphone, but for long ranges it is impossible without the anti-noise transmitter.

Radio Compass Installed.

One of the most important of the radio installations on these seaplanes is the radio compass. This consists of a set of revolving coils mounted in the tail of the machine, on which are mounted many turns of enameled copper wire. The radio waves are picked up on these coils by revolving the coils until the radio signals obtained on two methods of connection are of the same strength.

The operator then knows the direction of the incoming waves. By then reading the position of a pointer on a scale on the coils, the bearing of the transmitting radio station is determined. This bearing is then communicated by the radio operator to the navigating officer by means of the intercommunicating telephone, which consists of telephone receivers built into the helmets, and the same type of microphone used by the operator.

Using the same inter-communicating telephone system, the navigator can telephone to the pilots, giving them the proper direction in which to steer the 'plane. He may inquire of the engine room regarding the condition of the engines, or he may hold radio telephone conversation with the navigating officer on one of the other 'planes.

In other words, the inter-communicating telephone makes possible constant communication between all members of the crews in spite of the terrific noise caused by the engine and the wind rush, and in spite of the fact that they are located in separate parts of the seaplane. In addition to this the radio telephone makes it possible for the commanding officer and navigators to talk directly with each other, altho their seaplanes may be flying at a distance of 20 miles apart.

The radio compass signals may be received from a destroyer at a distance of 75 miles, or from large land stations at a distance of 600 miles.

The regular receiving apparatus on the seaplanes will permit of reception from land stations of high power at distances of several thousand miles, thereby permitting the seaplanes to copy weather reports or orders directly from the Navy Department at Washington.

The main striking fact regarding this radio equipment is that, completely installed, it weighs only 200 pounds.

Radio Reply in Three Minutes.

As an example of the efficacy of the seaplane's radio communication the following will serve:

The Navy Department communicated with the seaplane NC-4 after she started on her flight to Halifax, received a reply from Commander Read, and had broadcasted to Europe and the west coast of the United States the plane's position in *three minutes* elapsed time.

The message filed by the Navy Department at 11:18 A. M. was as follows:

> What is your position? All keenly interested in your progress. Good luck.
>
> (Signed) ROOSEVELT.

At 11:20 A. M. this answer was received:

> Thank you for good wishes. The NC-4 is twenty miles southwest of Seal Island, making eighty-five miles per hour.
>
> (Signed) READ.

At 11:21 A. M. the substance of Read's message was sent broadcast from the Annapolis (Md.) and New Brunswick (N. J.) radio stations, reaching Europe, South America, the west coast of the United States, and Honolulu. At 11:26 A. M. the radio stations at Balboa, Canal Zone, and San Diego, Cal., had confirmed receipt of the message.

New Navigation Instruments.

Three new and novel instruments for airship navigation have been invented and employed for the first time by the NC-1, NC-3 and NC-4 in the trans-Atlantic flight. They are an *aërial sextant,* a drift and *speed indicator,* and a *course and distance indicator.*

No airplane has ever flown far enough out to sea to warrant the use of the sun, moon and stars for fixing a geographical position, stated the Navy Department in announcing the use of these instruments. An instrument has been designed that will enable the air navigator to locate his position, regardless of the state of weather and regardless of the very fast speed of the airplane. An equal feature of the aërial sextant, known as the *Byrd sextant,* invented by Lieutenant Commander H. L. Byrd, is that a bubble in a tube takes the place of the sea horizon and observations. A specially constructed lens is used in sighting the bubble, which is reflected in a mirror. The sun is reflected in another mirror. The observer brings the sun tangent to a line at the same time he brings the bubble tangent to the line. That gives the altitude of the sun. This is of especial value, as the aviator is often above the clouds, and even when flying at low altitudes the horizon is too dim to be seen clearly. With this new aërial sextant the curvature of the earth does not have to be taken into consideration in calculating position. *The bubble is lighted at night, so that night observations may be taken.*

New Chart Saves Time.

New methods of astronomical calculations also have been devised which enable the navigator to make his calculations in a fifth of the time that was formerly neces-

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sary. A projection chart of the Atlantic Ocean has been specially constructed for this purpose. This chart, a new invention, does away with difficult mathematical calculations, enabling the aviator to determine his position in a few minutes.

Another great problem of the sea-air navigator is the calculation of the speed and direction of the wind, both day and night. In spite of the reliability of the compass it can only give the course upon which the craft heads, and in determining the true course proper allowance must be made for the sidewise drift caused by the wind. For example, a wind blowing thirty miles an hour towards the side of the 'plane will blow it thirty miles an hour out of its course. This fact alone makes the navigation of the air far more difficult than the navigation of the sea.

To overcome this difficulty bombs have been invented which ignite upon striking the surface of the water and give a dense smoke and bright light for ten minutes. An instrument is used in conjunction with this bomb which enables the navigator to determine the velocity and direction of the wind by sighting on the smoke in the daytime and the lights at night. This instrument, *called the speed and drift indicator, has proved successful.* This instrument is illustrated in one of the accompanying photographs.

When the navigator has found the speed and direction of the wind, he must then be able to calculate the course to steer towards the Azores to allow for this wind. To do this an instrument has been designed to solve the triangle of forces, thus doing away with intricate mathematical calculations.

In the Navigator's Cockpit.

The navigator's cockpit is in the forepart of the boat and is equipt with a chart board, a chart rack and lights. He also has a specially designed headgear for telephone communication with the pilots, so that he can direct them when to change course. The noise from the four big motors is so great that it is impossible to hold conversation except with specially designed telephonic apparatus.

The navigator also has instruments which show him the altitude of the 'plane and the time the sun keeps with the Greenwich meridian, because in going to the eastward so rapidly it is difficult to keep the correct time. In going from Newfoundland to the Azores over two hours is lost in a period of twenty hours, so that the navigator must be very expert in order to allow for this loss in time in making his astronomical calculations. In aërial navigation positions must be determined very quickly. The navigator sits down to work out his "sights," to fix his position, and will be far from his calculated position unless he works out his calculations very rapidly, which these instruments enable him to do.

Ocean Station Ships Bear Numbers.

Each ship had her number painted in large letters upon her deck so that the fliers can tell at a glance just where they are and how far they have progrest, since the positions of the destroyers and battleships were fixt in advance, and on one of the many charts which the aërial navigators had before them these positions were carefully marked.

When the word was flasht by wireless from Trepassey that the NC's had started off the nearest destroyers put out great black smoke smudges which the commanders of the flying boats were able to see for many miles.

At night the guiding surface ships were grouped much closer together.

The vessels had their searchlights directed aloft, had their identification numbers on the decks illuminated, and from time to time threw up star-shells of the sort which the combatants in the late war used to illuminate no man's land.

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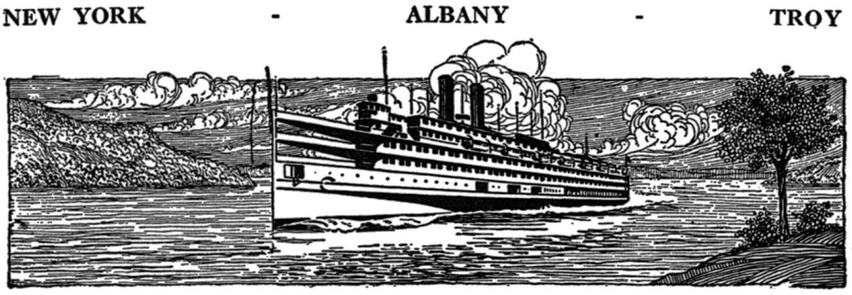

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The NC's carried flares, which could be dropt to light up the surface of the water in case a landing became necessary at night, and their commanders had "rocket-pistols," which threw out balls of varicolored fire for signalling purposes.

Electric Self-Starters Used.

The Bureau of Steam Engineering was able materially to improve the performance of the boat by the application of new propellers, designed in that bureau. The NC-1 was originally fitted with standard navy low compression Liberty engines, which were found to be entirely satisfactory, but during the period that the NC-1 was being tested with these engines the Bureau of Steam Engineering, at the experimental laboratory at the Washington Navy Yard, perfected carbureter adjustments on the high compression Liberty engines which materially improved its economy.

Since the high compression engine gave greater power than the low compression engine, such engines replaced the original installation on the NC-1. With the new propellers and the new engines, the boat got out of the water and flew easily, with a total weight of 24,700 pounds. The designed load was 22,000. Besides providing propellers and engines for the boat, the Bureau of Steam Engineering supplied a remarkably efficient *electric self-starter* to each engine.

This style of self-starter weighed only 35 pounds, and by means of this improvement it was possible for the pilot to start any engine without leaving his seat. It is believed that this constitutes the first application of an electric self-starter to the Liberty engine.

Wing span from tip to tip, 126 feet.

Upper wing from tip to tip, 114 feet.

Aileron projections beyond wing tips, 6 feet on either side.

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Width of wings, 12 feet.

Distance between wings, 14 feet at center and 12 feet at outer tips of lower wing.

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Length of hull, 44 feet 9 inches.

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Weight carried per square foot of wing surface, 12 pounds.

Estimated speed at full load, 79 nautical miles per hour.

Estimated speed at light load, 84 nautical miles per hour.

Horsepower of four Liberty engines, 1,600 horsepower.

SAWING A 74,000-Lb. STEEL INGOT.

(*Continued from page* 208)

It is an interesting fact that in cutting steel beams and ingots with these cold saws that *the saw proper never touches the steel* or iron stock; the cutting is done by a film or layer of comprest air just in front of the teeth. This comprest air layer is formed due to the high velocity of the saw blade, which is often several thousand revolutions per minute.

Some most interesting tests were recently made with these inserted tooth saws under regular working conditions. A 24-inch diameter blade cutting rails, peripheral speed 51 feet, lateral feed 27/32 inch per minute showed, before sharpening, a total of 424 cuts; after sharpening, a total of 502 cuts.

In an endurance test of a 40-inch saw with the lateral feeds on .45 carbon machinery steel, 12-inch round stock was cut in 5 minutes and 9-inch round stock cut in 35 seconds. The lateral feed guaranteed in the latter case was 2 inches per minute.

—*By Frank C. Perkins.*

Practical Chemical Experiments

By Albert W. Wilsdon

(*Continued from page 220*)

with Turpentine, Benzine, Naptha, or Gasoline, but old paint spots must be softened with oil or grease, and may then be removed by the appropriate solvent. Pitch, tar, or varnish may be treated with oil, and then be dissolved out with turpentine.

Sugar spots are soluble in warm water. If acids have destroyed the color of the goods, this may usually be restored by ammonia, and dilute alcohol may be used in the same way for the stains from fruits.

Removing Ink Stains.

It would be a much simpler task to remove ink spots if we only knew the composition of the ink in advance. Fresh ink usually dissolves in cold water, tho sometimes sour milk is more efficient. Ink stains may also be removed with blotting paper or some other absorbent. On marble, these stains may be treated with turpentine, baking soda, or strong alkalies, or a paste may be made with the alkali and turpentine, and this may be left for some time in contact with the spot, and finally washed off with water. A dilute solution of oxalic acid may often be used successfully to remove either ink stains or iron rust spots.

If there is much iron in the water supply, this may be removed from bowls or other porcelain ware by the use of hydrochloric acid, then rinse with water, and finally with a solution of soda.

It has probably often been noticed that silver is readily tarnished by sulfur, either from eggs, or from rubber bands or elastic, or sometimes from the sulfur compounds in the illuminating gas. The sulfid of silver thus formed is in color from grayish to black. Silver thus tarnished should be rubbed with moist common salt before washing, thus forming a chorid of silver, which may then be washed in ammonia, in which it is soluble.

For cleaning and polishing brass and copper, nothing is better than oil and rotten-stone, and most of the good polishes on the market are made from these materials, with alcohol, turpentine, or soap. Kerosene is useful in keeping metals bright, as well as glass and wood. Aluminum may be cleaned by the use of whiting or any silver polish, but alkalies should not be used upon this metal. As aluminum does not tarnish readily, and does not rust, it is an ideal substance from which cooking utensils are made.

Iron-Rust Stains.

To remove an iron-rust spot from a piece of goods, stretch the cloth over a dish containing hot water, then as the steam arises and the goods become moist, drop a little hydrochloric acid upon the rust spot with a medicine dropper. See Fig. 3. After a moment or two lower it into the water. If the spot is not removed, repeat the operation, then rinse in clear water, and finally in a dilute solution of ammonia to neutralize any acid that might remain and injure the goods.

Iron-rust stains may often be completely removed from delicate fabrics by the use of lemon juice and common salt.

QUESTIONS AND ANSWERS

Detecting Saccharine.

Q. 10. Werner Kretschmer, of Demarest, N. J., wants to know:

(1) The test for Saccharine, and (2) Method of detecting Glycerine in foodstuffs. (3) If the "Fuller's Earth" method of testing butter for coal-tar dyes can be applied to foodstuffs.

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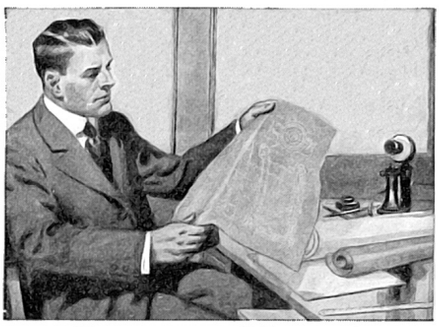

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Practical Telephony	BOOKKEEPER
MECHANICAL ENGINEER	Stenographer and Typist
Mechanical Draftsman	Cert. Pub. Accountant
Ship Draftsman	Traffic Management
Machine Shop Practice	Commercial Law
Toolmaker	GOOD ENGLISH
Gas Engineer	STATIONARY ENGINEER
CIVIL ENGINEER	CIVIL SERVICE
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solely for this purpose, the preserving influence being only incidental. In the detection of saccharine the substance containing it, which is usually a liquid, is shaken with chloroform, which settles to the bottom and is removed by means of a medicine-dropper. The saccharine enters into solution with the chloroform while sugar if present does not. The chloroform solution is then evaporated by heating gently on the water bath, and if saccharine has been present the residue has a distinctly *sweet* taste. This method is not applicable to substances whose chloroform layer contains a flavor that would mask the sweet taste of the saccharine, for instance, ginger ale.

(2) You fail to state what foodstuffs you desire to test for the presence of glycerine. It is essential that this be given as the methods of procedure to test for this substance is too varied to give a condensed test which would be applicable to all foodstuffs.

(3) The Fuller's Earth test which you mention may be used for the detection of coal tar dyes in foodstuffs other than butter.

MUSTARD GAS

Q. 11. Clayton Doolin, of Decatur, Ill., desires information regarding "Mustard Gas" and how it is obtained.

A. Mustard Gas is obtained by volatilizing Mustard Oil (Allyl Isothiocyanate). This is prepared by distilling macerated black mustard seeds with steam. Mustard seeds contain a glucoside "potassium myronate," which is soluble in water; its solution gradually undergoes fermentation (owing to the presence of an enzyme, "myrosin"), mustard oil, glucose and potassium hydrogen sulfate being produced. Allyl Isothiocyanate may be obtained synthetically by heating Allyl Iodid with Potassium Thiocyanate; it forms a liquid slightly soluble in water, of irritating odor, inciting to tears and producing blisters upon the skin.

ATMOSPHERIC NITROGEN

Q. 12. James G. Peck, Elmira, N. Y., has heard that a mixture of Nitrogen and Oxygen, when subjected to a succession of electric sparks will form *Nitric Oxid*. He wants to know if the same result will be obtained by using a mixture of the two gases as they occur in the air; in other words, by subjecting ordinary air to a powerful electric discharge in an enclosed chamber.

A. The subjecting of Atmospheric Nitrogen to a succession of electric discharges is at the present time successfully operated, for the formation of Nitric acid and Nitrates. Fig. 4 depicts the Birkeland and Eyde furnace of a later type. The individual furnace may be described as a low, wide cylinder resting upon its side and placed between the arms of an enormous horseshoe magnet. The cylinder is made of heavy iron plate and consists of similar halves, which are bolted together. The interior is lined with refractory brick, so arranged that in the middle there is a narrow circular chamber, over 6.5 feet in diameter and about 3.9 inches in width. In this circumscribed space the reaction takes place. The huge terminal poles of the wrought iron electro-magnet, beveled at the extremes, are embedded in the chamotte lining, and are about 9.8 inches apart, their axes corresponding with that of the chamber. The electrodes are of copper, with internal circulation of water, and are .59 inch in diameter. They enter the chamber from opposite sides, and are separated from each other at its center by an interval of about .31496 inch. Air under pressure is admitted to passages between the external shell and the chamotte lining, and enters thru numerous small inlets in the latter, into the reaction chamber. The gaseous current issues, thru openings in the periphery of the chamber, into a conduit which leads to the absorption apparatus. A small

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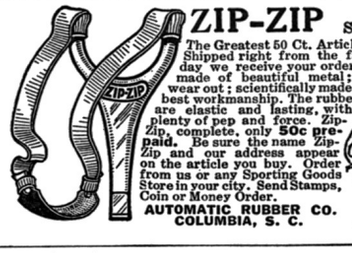

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window of mica in the front of the furnace allows inspection of the operation. A direct current feeds the coils of the big magnet located immediately outside the iron shell, and an alternating current is connected with the electrodes. This current is one of 5,000 volts, 50 cycles to the second. The most striking features of such a furnace are its simplicity and its durability. There are no movable parts. When in uninterrupted operation the electrodes are changed every three or four weeks, while the refractory lining is removed once or twice a year. Repairs are easy to make.

When in operation, a glance thru the window reveals the intensity of the reaction going on at a temperature of over 3,000° C. The result of the process is measured by the percentage of nitric oxid contained in the air issuing from the furnace.

Chemically, the reaction in the furnace between the oxygen and the nitrogen of the air is represented by the equation

$$N_2 + O_2 = 2NO$$

That is, one molecule of oxygen unites with one molecule of nitrogen to form two molecules of nitric oxid, a colorless gas.

The nitric oxid unites readily with free oxygen, at temperatures below 620° C., to form nitrogen peroxid, a brown gas, with the formula NO_2, at temperatures above

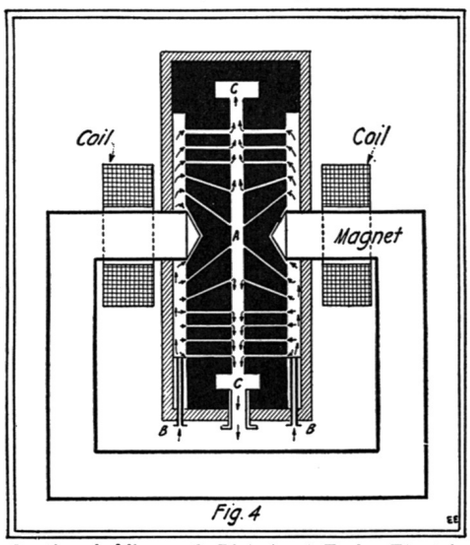


Fig. 4

Sectional View of Birkeland-Eyde Electric Furnace Used in Fixation of Atmospheric Nitrogen.

140° C., and the formula N_2O_4, at low temperatures. The peroxid condenses at 22° C. to a liquid which at —30° C. congeals to a mass of colorless crystals. As the temperature falls from 140° C. the number of molecules of N_2O_4 in a given volume steadily increases, as shown by the increase in density and the change in color from a deep brown to a reddish brown, and then to a yellowish brown. At 60° C. half of the molecules in the gas are of the formula N_2O_4. At 28°C. they constitute 80 per cent.

When the peroxid comes in contact with water it is dissolved and reacts, forming nitric acid and nitrous acid, thus:

$$2NO_2 + H_2O = HNO_3 + HNO_2$$

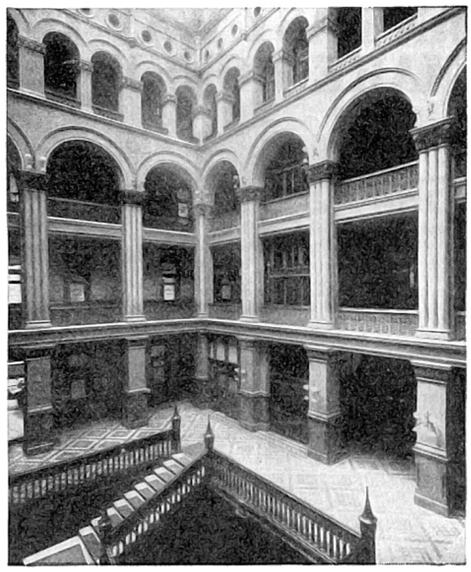
With an excess of peroxid the nitrous acid is oxidized to nitric acid and nitric oxid is liberated:

$$NO_2 + HNO_2 = NO + HNO_3$$

The net result of these two reactions is that two-thirds of the nitrogen peroxid is transformed into nitric acid, according to the equation:

$$3NO_2 + H_2O = 2HNO_3 + NO$$

The liberated nitric oxid, in the presence of oxygen and water, repeats the cycle of changes given above, so that theoretically it is possible to change to nitric all the nitrous oxid in the current of gas issuing from the nitrate furnace.



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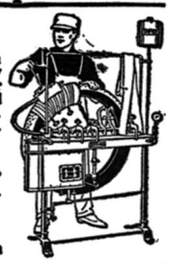

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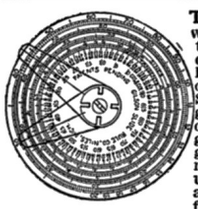

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New 1 K. W. Panel Radio Transmitter

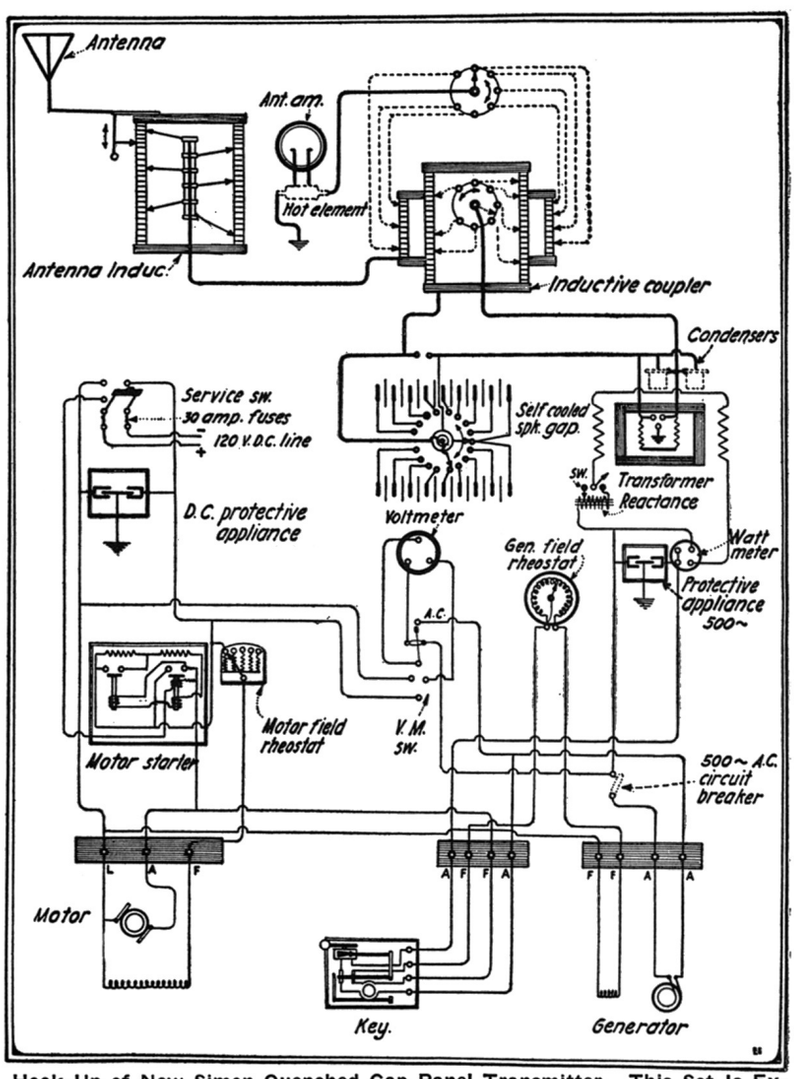
(*Continued from page 230*)

principle an insulated, two-pole circular switch for controlling 16 gap units. It permits the quenched discharge to take place between any number of gaps from 1 to 16, but allows the group of gaps used to be selected at any available part of the series of gaps, and shifted by the simple rotation of two hand wheels at once, as a unit. Each gap unit is air-tight, self-contained, and may be renewed independently of the rest by hand. The circuit is automatically and instantly closed after the break made by removal. Each gap is mounted in a vertical plane, in two horizontal rows of eight gaps each. Each gap unit consists of two brass discs with highly polished silver annular rings which are soldered to the discs. They are separated by fish-paper gaskets, each gap being set to spark at 1000 volts. One of the most important pieces of apparatus on the panel is the coupler and wave changer, consisting of a fixt primary coil and movable secondary coil. They are designed to have corresponding turns as tuning points in each, making simultaneous contacts with two rotating selector arms.

The three openings at the left-hand side of the coupler in Fig. 1 show the wave lengths, the correct wave length being read only at the center or bottom opening.

The thermo ammeter is used in connection with the Weston shunt-block, one end being grounded to the panel frame. It reads from 0 to 15 amperes.

From actual operating tests at full power, this set will radiate from 15 to 18 amperes antenna curent and has a daylight transmitting range of approximately 1000 miles, under normal conditions.—*Photos courtesy Emil J. Simon.*



Hook-Up of New Simon Quenched Gap Panel Transmitter. This Set Is Extensively Used in Naval and Commercial Ship Stations as Well as Land Stations.

AN ELECTRIC SHOOTING GALLERY

(*Continued from page 222*)

rection of rotation, thus hauling the target carrier to the rear of the range. Of course, behind the target there may be arranged the usual plank in which the bullets can imbed themselves. A piece of two-inch plank is very serviceable for the purpose, and where there is the least danger of any one passing behind the partition or behind the targets, the planking should be made about five feet high and three to four feet wide, and this in turn backed up by 1/16 to ⅛ inch steel sheeting.

Where hard-shooting pistols or rifles are used, it sometimes becomes necessary to back up a plank target such as this, backed with a wall of sand about 2 to 3 feet thick. —*Photo courtesy General Electric Co.*

GENERAL SQUIER WINS FRANKLIN MEDAL.

At a meeting of the Franklin Institute held on Wednesday, May 21, Major General George Owen Squier, Ph.D., Chief Signal Officer of the U. S. Army, was presented by the Institute with the Franklin Medal for important work which he has done during the war in the Signal Corps Branch of the Army.

In addition to this a Franklin Medal was also presented to Major General James Douglas McLachlan on behalf of His Britannic Majesty's Government for Sir James Dewar, Jacksonian Professor of Experimental Philosophy, University of Cambridge; Fullerian Professor of Chemistry, Royal Institution, London, for important work which he had done for the British Government in the World War.

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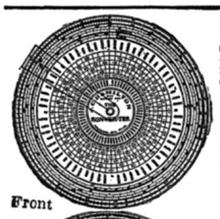

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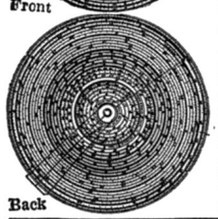

Back

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A 100 Horse-Power Voice

(*Continued from page 212*)

speaker. Each afternoon the Navy Department at Washington sends by wireless the correct time to ships at sea. This message was picked up on several occasions and transmitted to the crowd at the "Way."

The loud speaker equipment employed at the "Way" was the same as that used aboard ships of the U. S. Navy during the war to make orders heard in every part of the ship.

The speakers' stand at "Victory Way" was in the center of the "Way." On this stand there was a small and extremely sensitive transmitter—so sensitive that it was not necessary for the orator to talk into it. It comprised a battery of three microphones. He merely talked in front of it, and the sensitive transmitter carried the electric current, whose variations represented his enunciations to the control room at the rear of the speakers' stand. There the amplification apparatus boosted the sound waves 7,500,000,000 times and shot it out to the *loud speaker* receivers, *one hundred and twelve* of which were strung above the heads of the audience, twenty feet apart, up and down the whole length of the "Way." The amplifiers comprised a large number of Audions or so-called *talking bottles.* These receivers were very sensitive telephone receivers of special design, with large megaphones or horns, to make the speech audible to those standing below. The area covered by the loud talkers was about 60,000 square feet.

The transmission of the speech from Washington, however, involved much more. The speakers at the National Capitol used a special telephone set and, of course, they also had a *loud speaker* receiver, so that they might hear the applause from New York.

In the case of the message from the Dirigible C-4, the transmitter on the speakers' platform was connected, not only with the loud speaker receiver, but with wireless as well, which transmitted waves to the radiophone aboard the dirigible.

The antennae for the radiophone communication were stretched between the Hotel Avignon and the Railroad Y. M. C. A. Building, which are on opposite sides of "Victory Way," with a wireless apparatus in the latter building, from which the messages were wired to the control room and the loud speaker circuits.

The control room was elaborate and contained a mass of wires and switches and special electrical devices, developed by engineers of the Bell Telephone System. This room contained the amplification apparatus, means for generating the electric current use, and switching devices used for connecting with the long distance wires to Washington and the wireless.

Electric locomotives past beneath the street in the tunnel of the New York Central Railroad. To avoid electrical disturbances from these, the control room was completely covered with sheet iron, which was grounded, so that the control room was isolated electrically. Also the amplifier bulb cabinets were suspended from the ceiling on rubber cords.

No loud speaker receivers were placed within eighty feet of the speaker on the platform, because in that case the speaker's voice, as it came from his throat, and as it poured down thru the loud speaker receivers, would play a race in which the sounds from the receivers would reach the auditor first, because of the fact that electrical waves travel at a far greater rate of speed than mere sound waves. If loud speaker receivers were near the orator, the result would be a bedlam of sound, as the words overlapt one another.

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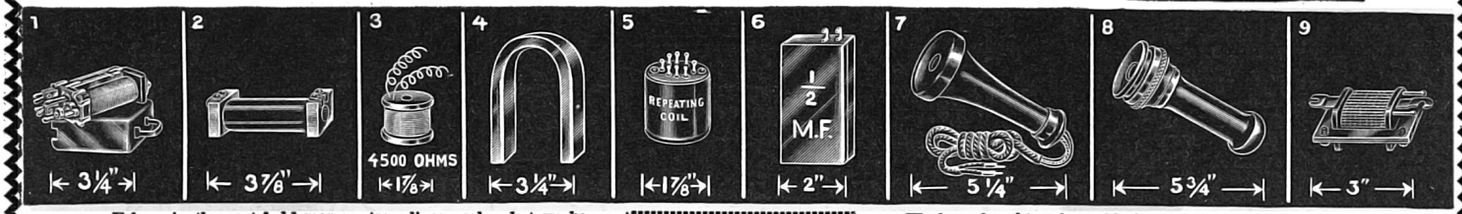

WE have in the past held many extraordinary sales, but we believe that the present one eclipses all by the wonderful values we are offering. The goods which we offer on this page are all standard telephone apparatus. Every piece we are offering is equipment that for one reason or another was discontinued by the telephone companies. If you wanted to buy any of the pieces which we offer herewith, from the manufacturers, the price would at least be ten times what we are asking for it. You can readily ascertain this for yourself by looking over our wonderful prices.

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No. 1 Relay—shipping weight, 2 lbs. Price..... **$1.50**

NO. 2 STANDARD TELEPHONE Induction Coil, primary 1 ohm, secondary 55 ohms. Used wherever you need a good induction coil. Has primary and secondary and iron wire core; fibre heads.
No. 2 Induction Coil as described—shipping weight, 2 lbs. Price..... **$0.50**

NO. 3 STANDARD RESISTANCE wound with German silver wire—4,500 ohms, can be used as a choke or plain resistance, and has many other uses that readily suggest themselves to the experimenter.
No. 3 Standard Resistance as described—shipping weight, 4 oz. Price..... **$0.40**

NO. 4 HORSESHOE MAGNET, size 3¼ inches wide x 5 inches high. Will lift about 1 lb. Quality such as used on magnetos, which means the best.
No. 4 Horseshoe Magnet — shipping weight, 2 lbs. Price..... **$0.30**

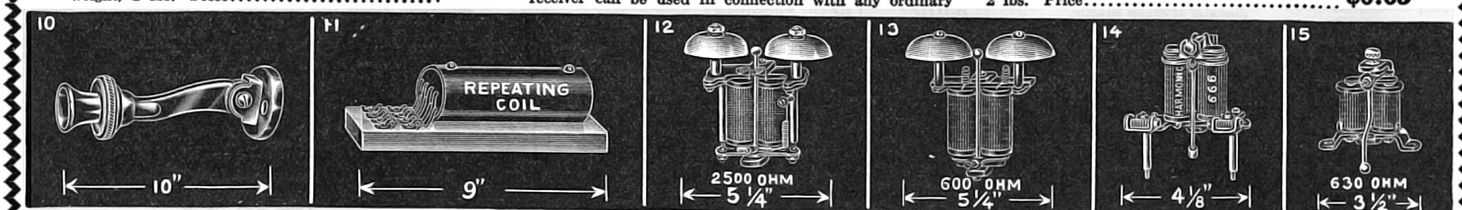
NO. 5 REPEATING COIL (Transformer). This is a standard small repeating coil and is used by all telephone companies. It has 4 different windings and eight contacts. Entirely enclosed in iron. The resistance being respectively 72 and 120 ohms, and 90 and 100 ohms. Diagram is furnished. Can be used for wireless, for boosting signals, etc.
No. 5 Repeating Coil—shipping weight, 2 lbs. Price..... **$0.50**

NO. 6 ½ M.F. CONDENSER. This is a standard telephone condenser and has ½ microfarads. Condenser comes in neat metal casing. This condenser is used in connection with spark coils to absorb the vibrator spark. Invaluable for test buzzers to absorb spark and make the sound of buzzer more steady. Is also used by every experimenter in connection with wireless where a fixed capacity is needed. Several of these condensers should be in every experimenter's laboratory.
No. 6 Condenser, ½ M.F.—shipping weight, 1 lb. Price..... **$0.50**

NO. 7 DOUBLE POLE BELL TELEPHONE RECEIVER—hard rubber casing with 4 ft. cord and tips. Standard 75 ohms—very powerful magnets. This receiver can be used in connection with any ordinary telephone work, and you will even find it sensitive enough for short distance wireless work.
No. 7 Bell Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.80**

NO. 8 STANDARD TELEPHONE RECEIVER with Metal Head. This receiver is made by Stromberg Carlson Co., with genuine hard rubber handle and ear cap. A very good fool-proof as well as sensitive receiver that cannot be put out of order if you try. Used for the same purpose as No. 7 Telephone Receiver.
No. 8 Standard Telephone Receiver—shipping weight, 3 lbs. Price..... **$0.75**

No. 9 IMPEDANCE COIL (Close Core Transformer). This is a very fine little transformer and is used extensively in connection with telephone work. It is in reality an A.C. transformer for which you would pay $5.00 if you had it made to order. The primary has 0.15 ohms, secondary 2000 ohms. It can be used for a variety of purposes that will suggest themselves to every experimenter. Can be used successfully to boost wireless signals. Also in connection with audions, etc. An A-1 instrument. Size 3 x 3 inches.
No. 9 Impedance Coil—shipping weight, 2 lbs. Price..... **$0.65**



NO. 10 MICROPHONE AND BRACKET. An A-1 sensitive microphone of the carbon grain type. Has hard rubber mouthpiece and enamel steel bracket, the instrument being 10 inches long. This microphone, in connection with our No. 7 or 8 Receiver, will constitute a complete telephone outfit, good to speak 50 miles or more, at a remarkably low price.
No. 10 Microphone and Bracket—shipping weight, 5 lbs. Price..... **$1.00**

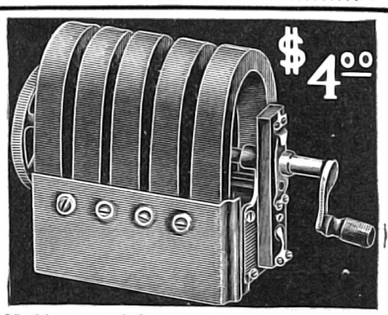
NO. 11 REPEATING COIL (Transformer). A standard repeating coil used for telephonic work. The coil windings are encased in an iron tube 2¼ inches in diameter. There are eight terminals for the four windings to connect to and the instrument is invaluable in connection with radio work to boost up signals, audion work, etc. Many interesting uses will be found for this coil. Resistances are: 100, 120, 145, 175 ohms.
No. 11 Repeating Coil—shipping weight, 8 lbs. Price..... **$2.00**

NO. 12 POLARIZED RINGER with Bells. The resistance of the two coils is 1250 ohms each. The armature is perfectly adjustable. Bell will work on any magneto. We also furnish blue print with ringer showing how *a first class polarized relay* can be made by anyone using only a few pieces of metal and screws.
No. 12 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.50**

NO. 13 POLARIZED RINGER with Bells. This is the same kind of ringer as the No. 12, except that it is not adjustable and that the resistance is less. First class in all respects. Blue print furnished with this to *make polarized relay* same as with No. 12. Solenoids on this ringer are worth more than the price we ask for the entire ringer, and do not forget a powerful magnet that goes with it.
No. 13 Polarized Ringer with Bells—shipping weight, 2 lbs. Price..... **$1.00**

NO. 14 HARMONIC RINGER. This ringer is also polarized and has a powerful magnet. It works on 66.6 cycles and any magneto will operate it if run at a certain speed. A very finely built instrument. Resistance of each coil being 200 ohms. Can be converted into a polarized relay by substituting a very fine leaf spring instead of the heavy one furnished. A most interesting instrument with which to experiment.
No. 14 Harmonic Ringer — shipping weight, 4 lbs. Price..... **$1.60**

NO. 15 RINGER without Bells—630 ohms. This also is a polarized ringer and has an adjustable armature. The adjustment is done by means of the top screw. A beautiful little instrument. With this instrument, too, we furnish a blue print showing how a *polarized relay can be built.* You should have several of these beautiful little instruments. They are worth their weight in gold; the powerful magnet alone being worth more than the price we ask for the entire instrument.
No. 15 Ringer—shipping weight, 2 lbs. Price..... **$0.80**



No. 55 5-bar magneto, 110 Volt A. C. Generator

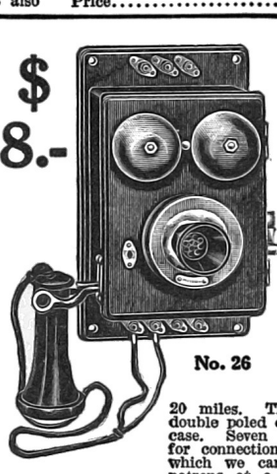
This is one of the most powerful magnetos ever built, when manufacturers could afford to put good stuff into them; equipt with transmission, make and break, etc. Transmission wheels are all brass, crank handle furnished. This magneto, as well as the other ones listed below, will light a 110-volt lamp merely by turning the crank handle slowly. While this magneto gives alternating current only, it can be rewound so it will light up a number of four, six and 10-volt lamps, all depending upon the thickness of the wire you wind on the armature. As we furnish these magnetos, they will give a powerful alternating current and you will not be able to stand the current when grasping hold of the terminals. This makes an ideal shocking machine. All our generators can be transformed into a direct current machine by equipping it with a home-made commutator. Machines are **A-1 in all respects and every** experimenter should have one of them in his shop. Many other experiments which can be performed with this machine will readily suggest themselves to any experimenter. The magnets furnished with these generators are very powerful, each one being able to lift one pound easily.

NO. 55 5-BAR MAGNETO GENERATOR as described—shipping weight, 25 lbs. Price..... **$4.00**

NO. 33 3-BAR GENERATOR, same as described above except that it has only 3 bars, and is somewhat smaller.
No. 33 3-bar Generator—shipping weight, 10 lbs. Price..... **$2.00**

NO. 44 4-BAR GENERATOR, same as No. 55 except that it has 4 bars, and is somewhat smaller.
No. 44 4-bar Generator—shipping weight, 15 lbs. Price..... **$3.00**

NO. 66 6-BAR GENERATOR, same as No. 55 except that it has one more magnet and the armature is somewhat larger and more powerful. This is the biggest type made and is extremely powerful.
No. 66 6-bar Generator—shipping weight, 30 lbs. Price..... **$4.50**



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This is a complete commercial telephone station. The cabinet is of polished oak, piano finish, within which is contained the powerful magneto, the 300 Ohm polarized ringer, and induction coil. The magneto is exceptionally efficient, being of the two bar type with brass gear transmission. The extra sensitive microphone, mouthpiece and two gongs are mounted on the front of the cabinet, giving the entire instrument that desirable appearance of compactness and efficiency. Guaranteed to work over 20 miles. The telephone receiver is a double poled one, and has a hard rubber case. Seven binding posts are provided for connections. The instrument is one which we can offer with pride to our patrons at a ridiculously low price. It is unobtainable anywhere else at less than $15.00 and is an instrument unequaled in value for the price we ask. Size over all 11" x 10" x 8". Shipping weight, 15 lbs.

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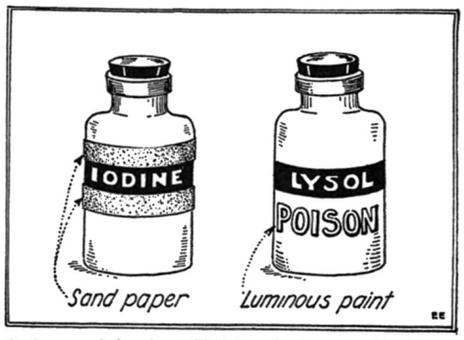


Safeguard Against Taking Poison in the Dark Unknowingly, Comprising Luminous Letters and Sandpaper Ring Around the Bottle.

Safeguard for Poison Bottles.

(327) Floyd Hoskins, Pine Bluff, Ark., writes: "Many people have killed themselves with poisons taken in a dark room by mistaking them for medicine bottles. I have an idea to safeguard the bottles by putting sand paper around them as per illustration. I also think that by having the word 'Poison' placed upon the bottle by means of illuminated paint, this would be an additional safeguard. Are these ideas patentable?"

A. The sand paper idea is quite an old one which has been described in the technical press many times. Sand paper has also been placed on stoppers as a safeguard. The idea of using illuminated paint, however, is new as far as we are aware, but we doubt very much if a patent can be obtained upon it. Applying luminous paint to various articles does not make a patentable combination so far as we know. It would be a good idea to get in touch with a patent attorney.

Electric Clock.

(328) Ernest Bostwick, Louisa, Ky., says: "Please advise me whether or not you think I could obtain a patent on a clock driven by electricity register hours, days, months and years."

A. Without having the details it is impossible to state if a patent could be obtained. There are at the present time a good many clocks in existence which indicate seconds, minutes, hours, months as well as the year. Unless you have a fundamentally new device, we doubt very much if a patent can be obtained.

Aërial Torpedo.

(329) E. F. Prucha, Howells, Nebr., wants to know if his idea on an aërial torpedo and aërial bomber and navigator which he has submitted with many illustrations and drawings is patentable.

A. After carefully looking over the drawings, we have come to the conclusion that there is nothing new involved in this invention, nor do we think it is practical. There are several features shown which may be patentable, but we doubt the practicability of the invention.

Demountable Rim Tool.

(330) S. W. Snelling, Newark, Ohio, has to say the following: "I have a little device that I think would be fine for automobilists. With this tool, you can take off and put on the demountable rim more quickly than it could be done today."

A. This seems to be a very good idea, and there also seems to be a good market for a tool of this kind. We think a patent can be obtained.

IN OUR NEXT ISSUE:

"How to Develop Your Inventive Ability" By Jay G. Hobson. Author of "How to Finance and Manufacture a Patent," publisht in our June, 1919, issue.

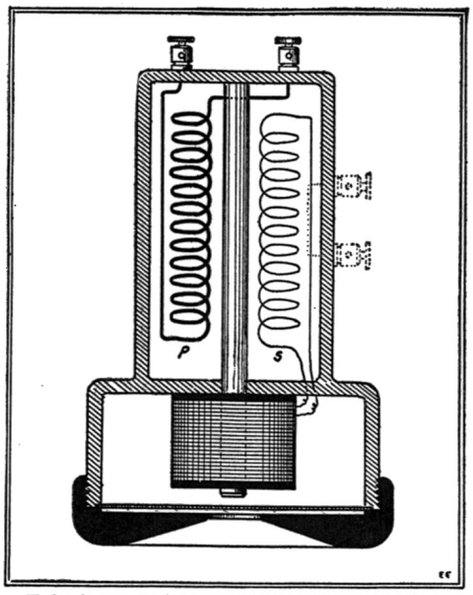
Nicotine Absorber.

(331) Philip Dubilier, New York, N. Y. submits sketch of a new device for cigarette holders which absorbs the nicotine of cigarettes. The idea in main is to have the holder in two parts to be screwed together. Between the two sections cotton can be placed which absorbs the nicotine.

A. We see nothing fundamentally new in this idea, as cotton or felt absorbers for nicotine have been made use of for many years. You might, however, obtain a constructional patent. Devices of this kind are not as a rule popular with smokers as they are very messy to handle, and the cotton gets clogged up too quickly.

Receiver-Induction Coil.

(332) Seth Card, Winthrop, Mass., says: "My idea is to have an induction coil in the handle



Telephone Induction Coil Inside Receiver

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of the telephone receiver instead of having the magnet run back into the handle as it usually does. In other words, I would have a combination telephone receiver as well as induction coil. Is the idea patentable and practicable?"

A. We take pleasure in illustrating the device on account of its originality. This certainly is a clever as well as capital idea. There is no doubt that this device will work, altho we think it would be somewhat less efficient than the regular combination by having the instruments separate.

Patents and Citizenship.

(333) Samuel Guyer, New York, N. Y., writes: "I have perfected an invention, but as I am not a citizen I dislike to ask for a patent. Do you think it is safe for me to apply for a patent?"

A. You need not be a citizen of the United States to apply for a patent. Anyone can apply and take out patents, but you will have to tell your patent attorney of what country you are a subject. This must be stated in the patent application. Otherwise, you will have no trouble in obtaining a patent, providing, of course, the idea is patentable.

Astronomical Facts for All

By Isabel M. Lewis

(*Continued from page* 217)

proximate to the total number of stars in our system. They have assumed a median magnitude of twenty-two or twenty-four, far below the reach of existing telescopes, and considering that there are as many stars below as there are above this median magnitude, they find the total number of stars to be between seven hundred million and eighteen hundred million.

2. *What proof is there that no atmosphere exists on the moon?*

There are no atmospheric phenomena visible on the moon, no evidence of storms, clouds or erosions of the rocky surface, no twilight effects, no haziness of the cusps, no signs whatever of the refraction of light by an atmosphere. When a star passes behind the moon, *or is occulted,* it disappears and reappears with startling suddenness. There is no gradual fading away of the star or change in its color such as would be noticed if its light had to travel thru atmospheric strata increasing in density toward the moon's surface. All shadows on the moon are sharp and black. There is no blurring or haziness of the outlines.

At time of solar eclipse there is no distortion of the sun's limb as the edge of the moon passes over it such as would arise if the sun's light past thru a lunar atmosphere and was refracted thereby.

Also, according to the kinetic theory of gases, the ability of a body to hold an atmosphere depends on its mass and density. Molecules of the gases are continually flying off in all directions. If their velocity exceeds a certain critical amount they may escape altogether from the gravitational control of the body in question.

For the moon this "velocity of escape" as it is called, is less than two miles per second. As the molecular velocity of all the gases of the earth's atmosphere, oxygen, nitrogen, etc., exceed this amount, it is evident that the moon could not hold these gases by its gravitational attraction.

3. *What can one expect to see with a three-inch telescope?*

The rings and three or four satellites of Saturn, the belts and four satellites of Jupiter, the snow caps and most prominent markings of Mars and, according to Prof. W. H. Pickering, a number of the canals of Mars if the condition of the atmosphere, or "seeing," is particularly good; also the craters and other markings on the moon in great detail, the sun-spots, faculae and, with spectroscopic attachment, prominences on the sun, the Great Nebula in Orion and many beautiful double and multiple stars.

If the telescope is equatorially mounted and provided with graduated circles for finding and identifying stars and nebulae, a most wonderful and valuable storehouse of knowledge is opened.

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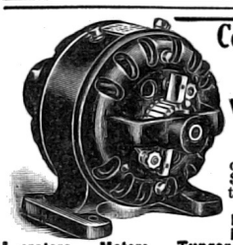

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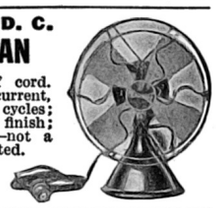

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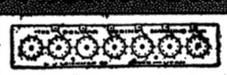

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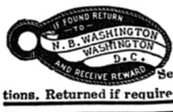

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Electrical Oscillators

By Nikola Tesla

(*Continued from page 229*)

Broadly, the instruments can be divided into two classes: one in which the circuit controller comprises solid contacts, and the other in which the make and break is effected by mercury. Figures 1 to 8, inclusive, belong to the first, and the remaining ones to the second class. The former are capable of an appreciably higher efficiency on account of the fact that the losses involved in the make and break are reduced to the minimum and the resistance component of the damping factor is very small. The latter are preferable for purposes requiring larger output and a great number of breaks per second. The operation of the motor and circuit controller of course consumes a certain amount of energy which, however, is the less significant the larger the capacity of the machine.

In Fig. 1 is shown one of the earliest forms of oscillator constructed for experimental purposes. The condenser is contained in a square box of mahogany upon which is mounted the self-induction or charging coil wound, as will be noted, in two sections connected in multiple or series according to whether the tension of the supply circuit is 110 or 220 volts. From the box protrude four brass columns carrying a plate with the spring contacts and adjusting screws as well as two massive terminals for the reception of the primary of the transformer. Two of the columns serve as condenser connections while the other pair is employed to join the binding posts of the switch in front to the self-inductance and condenser. The primary coil consists of a few turns of copper ribbon to the ends of which are soldered short rods fitting into the terminals referred to. The secondary is made in two parts, wound in a manner to reduce as much as possible the distributed capacity and at the same time enable the coil to withstand a very high pressure between its terminals at the center, which are connected to binding posts on two rubber columns projecting from the primary. The circuit connections may be slightly varied but ordinarily they are as diagrammatically illustrated in the ELECTRICAL EXPERIMENTER for May on page 89, relating to my oscillation transformer photograph of which appeared on page 16 of the same number. The operation is as follows: When the switch is thrown on, the current from the supply circuit rushes thru the self-induction coil, magnetizing the iron core within and separating the contacts of the controller. The high tension induced current then charges the condenser and upon closure of the contacts the accumulated energy is released thru the primary, giving rise to a long series of oscillations which excite the tuned secondary circuit.

This device has proved highly serviceable in carrying on laboratory experiments of all kinds. For instance, in studying phenomena of impedance, the transformer was removed and a bent copper bar inserted in the terminals. The latter was often replaced by a large circular loop to exhibit inductive effects at a distance or to excite resonant circuits used in various investigations and measurements. A transformer suitable for any desired performance could be readily improvised and attached to the terminals and in this way much time and labor was saved. Contrary to what might be naturally expected, little trouble was experienced with the contacts, altho the currents thru them were heavy, namely, proper conditions of resonance existing, the great flow occurs only when the circuit is closed and no destructive arcs can develop. Origi-

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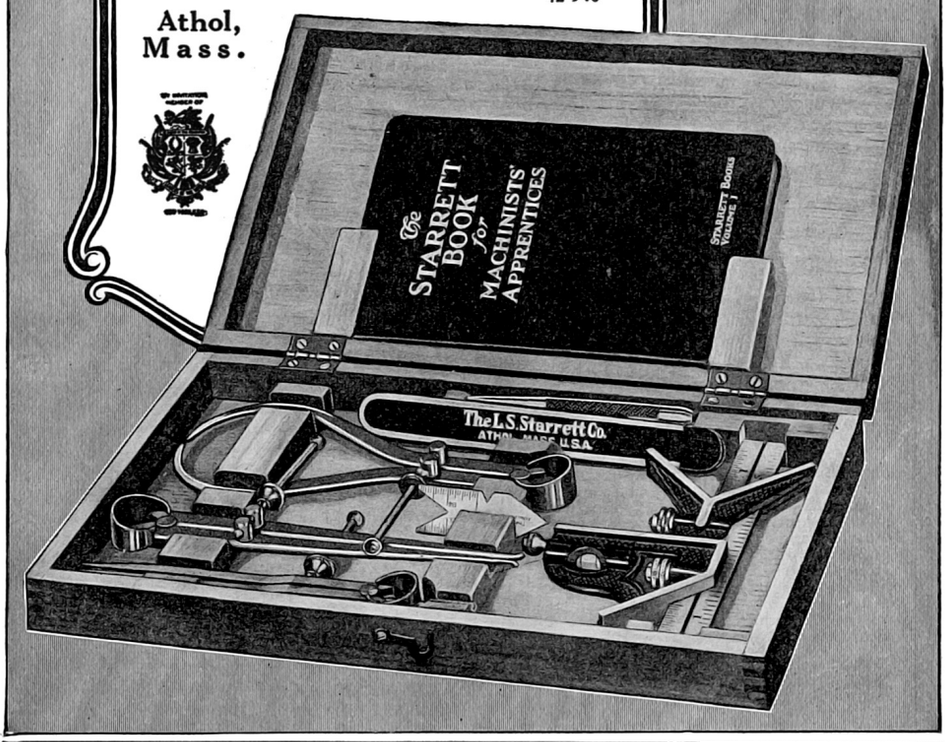

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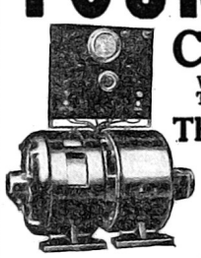

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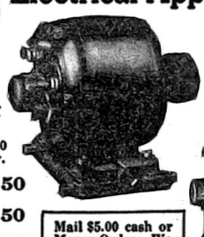

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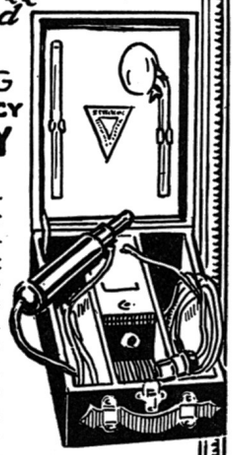

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nally I employed platinum and iridium tips but later replaced them by some of meteorite and finally of tungsten. The last have given the best satisfaction, permitting working for hours and days without interruption.

Fig. 2 illustrates a small oscillator designed for certain specific uses. The underlying idea was to attain great activities during minute intervals of time each succeeded by a comparatively long period of inaction. With this object a large self-induction and a quick-acting break were employed owing to which arrangement the condenser was charged to a very high potential. Sudden secondary currents and sparks of great volume were thus obtained, eminently suitable for welding thin wires, flashing lamp filaments, igniting explosive mixtures and kindred applications. The instrument was also adapted for battery use and in this form was a very effective igniter for gas engines on which a patent bearing number 609,250 was granted to me August 16, 1898.

Fig. 3 represents a large oscillator of the first class intended for wireless experiments, production of Röntgen rays and scientific research in general. It comprises a box containing two condensers of the same capacity on which are supported the charging coil and transformer. The automatic circuit controller, hand switch and connecting posts are mounted on the front plate of the inductance spool as is also one of the contact springs. The condenser box is equipt with three terminals, the two external ones serving merely for connection while the middle one carries a contact bar with a screw for regulating the interval during which the circuit is closed. The vibrating spring itself, the sole function of which is to cause periodic interruptions, can be adjusted in its strength as well as distance from the iron core in the center of the charging coil by four screws visible on the top plate so that any desired conditions of mechanical control might be secured. The primary coil of the transformer is of copper sheet and taps are made at suitable points for the purpose of varying, at will, the number of turns. As in Fig. 1 the inductance coil is wound in two sections to adapt the instrument both to 110 and 220 volt circuits and several secondaries were provided to suit the various wave lengths of the primary. The output was approximately 500 watt with damped waves of about 50,000 cycles per second. For short periods of time undamped oscillations were produced in screwing the vibrating spring tight against the iron core and separating the contacts by the adjusting screw *which also performed the function of a key.* With this oscillator I made a number of important observations and it was one of the machines exhibited at a lecture before the New York Academy of Sciences in 1897.

Fig. 4 is a photograph of a type of transformer in every respect similar to the one illustrated in the May, 1919, issue of the ELECTRICAL EXPERIMENTER to which reference has already been made. It contains the identical essential parts, disposed in like manner, but was specially designed for use on supply circuits of higher tension, from 220 to 500 volts or more. The usual adjustments are made in setting the contact spring and shifting the iron core within the inductance coil up and down by means of two screws. In order to prevent injury thru a short-circuit, fuses are inserted in the lines. The instrument was photographed in action, generating undamped oscillations from a 220 volt lighting circuit.

Fig. 5 shows a later form of transformer principally intended to replace Rhumkorf coils. In this instance a primary is employed, having a much greater number of turns and the secondary is closely linked with the same. The currents developed in the latter, having a tension of from 10,000 to 30,000 volts, are used to charge con-

(*Continued on page 276*)

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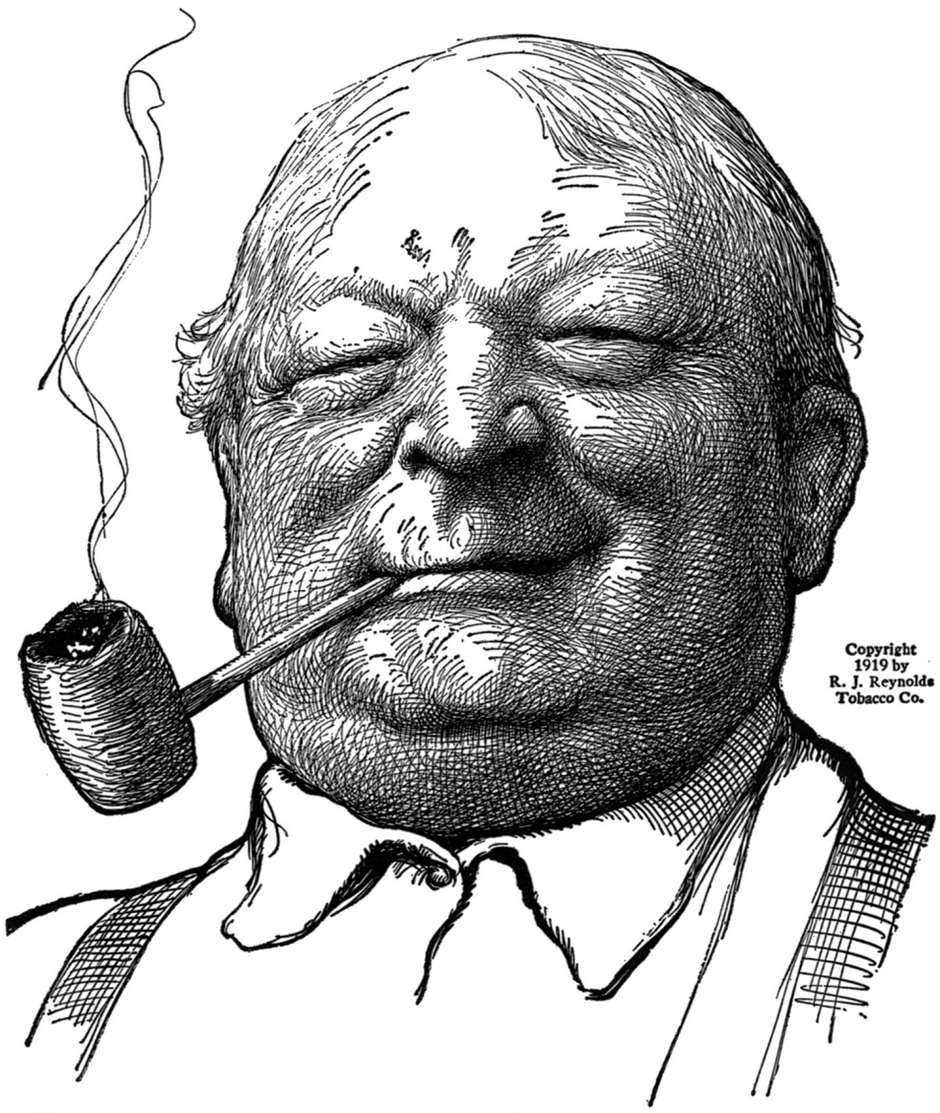

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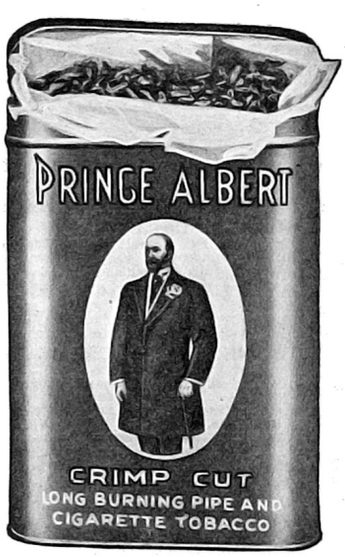

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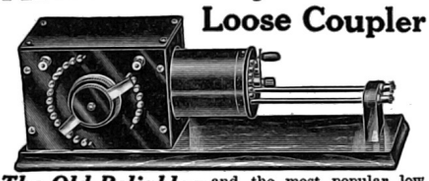

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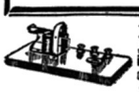

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"Hello Europe" --Via Radio

By Charles M. Ripley

(*Continued from page* 210)

the "high tension" and "high frequency" juice of the 20th century! A party of visitors arrives by automobile.

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The High Frequency Alternator.

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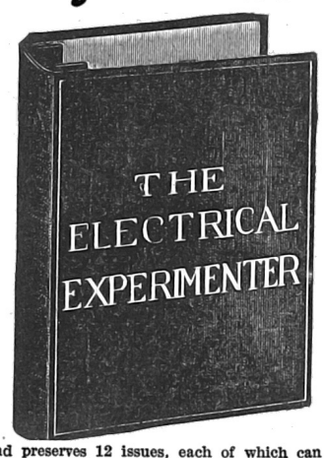

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called, weighs nearly 3 tons, with its shaft, and rotates at 2,100 revolutions per minute. This is not considered a high speed in the electrical profession, and yet if this rotating element were to roll along upon the ground at its present speed it would run from Schenectady, N. Y., where it was built, to New Brunswick, N. J., *in less than thirty minutes!*

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4. It is cool, clean and quiet in operation as a motor.

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Now in the case of both the trigger and the relay we have mechanical motion—i.e., moving parts. These moving parts introduce mechanical and electrical difficulties when it comes to handling large currents of electricity. These moving parts thus constitute the limitations of electrical amplifiers which depend upon mechanical motions. They are "the neck in the bottle."

But the magnetic amplifier has no moving parts, hence it has correspondingly less limitations. Its principle depends upon the invisible and *motionless action* of magnetism within the iron.

To return to the "trigger analogy." When

(*Continued on page 268*)

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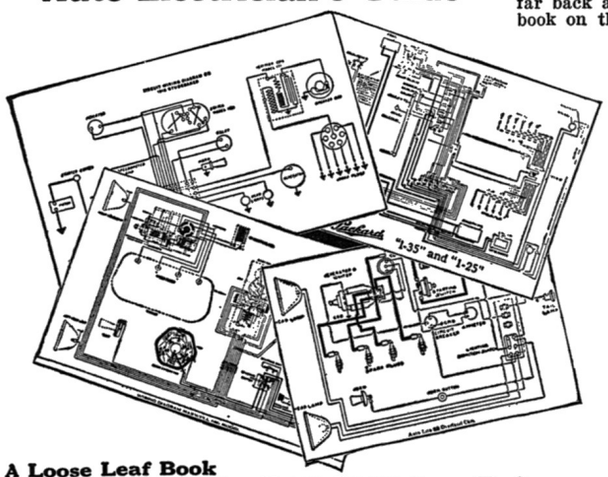

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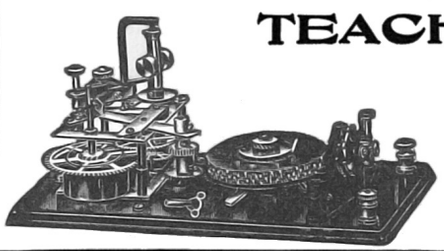

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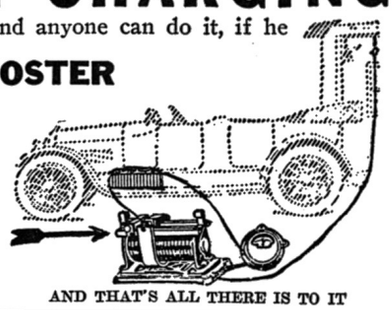

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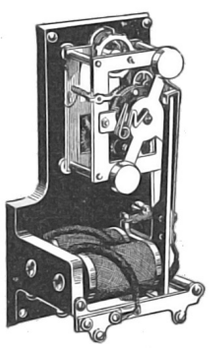

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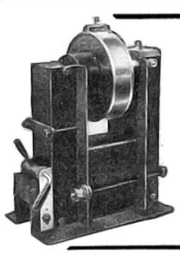

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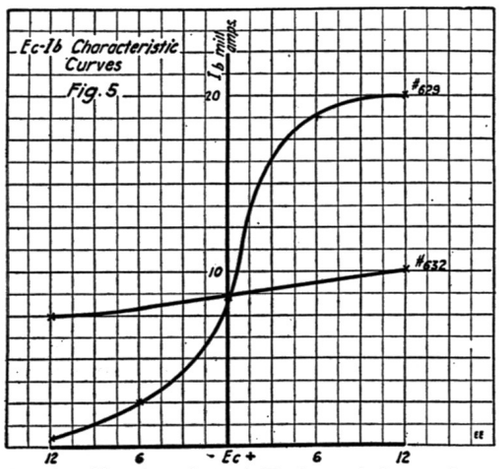
The Design, Pumping and Testing of Audion Tubes

By C. Murray

(*Continued from page 235*)

The writer plotted curves on two Fleming valves; one with a cylinder ⅜ inch in diameter and the other ½ inch diameter. The results are shown at Fig. 4. During the test Eb was kept at 200 volts and Ia was varied until a saturation point was found. The grid, as aforementioned, is the principal element, and it is upon this that the main action of the Audion tube is based. The size or surface area depends entirely on what it is to be used for.



Graphs Showing Actual Tests and Space Currents for Two Different Audions. Grid in Tube No. 629 Had Twice as Many Turns as Grid in Tube No. 632.

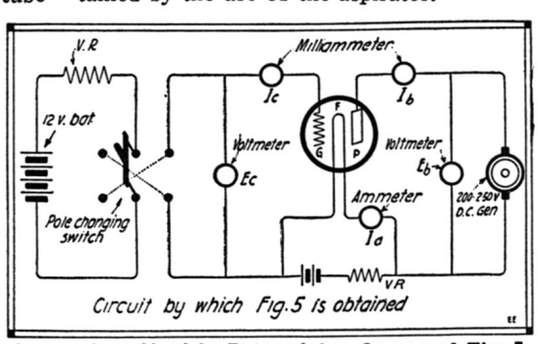
For instance, if we desire to use a tube for an *amplifier*, then we design it so that a small charge on the grid will produce a large effect on the plate current. If we wish to use it as an *oscillator* or power tube, it is not necessary or essential to have a large grid, but it must be constructed much heavier to prevent sagging during the pumping and while it is in operation as an oscillator.

The writer constructed two tubes with the grids as follows: The grid in tube No. 629 was made of .020-inch nickel wire, wound in the form of a spiral, ¼ inch in diameter, making a total of 26 turns. The grid in No. 632 tube was also the same diameter, but it only had 14 turns. The same plate spacing in both tubes was used. The results are used in graph Fig. 5. We can readily see that both tubes will give us 8 milliamperes of space current, when the grid is free, and by giving the grids a small negative charge one will drop almost to zero space current while the other only dropt to 7.5 milliamperes. We also find when we change the charge to positive that it will increase the Ib on No. 629 a great deal more than on the tube with the small grid.

By referring to the drawing of the vacuum pump, Fig. 1, the reader will see that it is constructed entirely of glass, with the exception of the mechanical pump or "backer." The *backing pump* used by the writer is of the rotary type and immersed in oil to prevent any leakage of air. With it a vacuum of from 8 to 15 mm. of mercury is readily obtained.

The *Aspirator* plays the principal part of the system and is indicated by 3, 4, 5, 6, and it is with this apparatus that we obtain the highest vacuum known to-day, which is very necessary in practically all vacuum tube work.

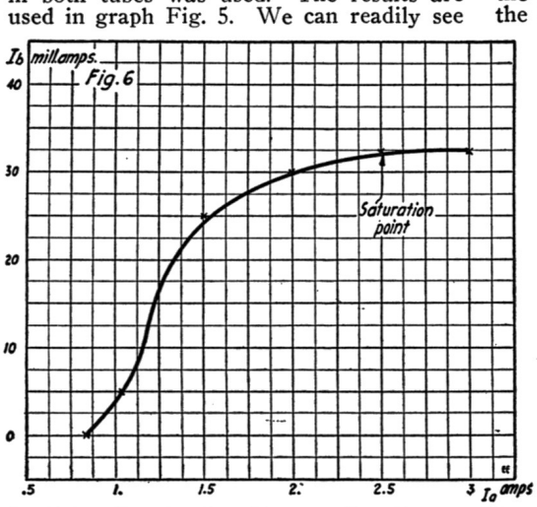
The mercury in the aspirator is used to absorb the gases which are generated by the bombarding or heating of the metal in the tube being pumped. The mercury must be heated to the boiling point before it starts its work of absorption. It has been estimated that a vacuum of 1 millionth of a mm. of mercury is obtained by the use of the aspirator.



Connections Used in Determining Curves of Fig. 5. For the Rest of the Curves the Grid Circuit is Omitted.

Liquid air is also used in the pumping process, to prevent or freeze any mercury vapor which has not been condensed on the walls of the aspirator from passing into the lamp while it is being pumped; for if we should allow a very small amount of the mercury vapor to get into the tube it would cause it to show a blue haze, thus greatly reducing its sensitiveness and it would heat up considerably.

We will here describe the pumping of tube No. 632 in detail: First the tube was sealed on the pump and an electric oven was placed around the tube. The mechanical pump was started, the current turned on in the oven and also the aspirator heater—the liquid air was placed in a "Thermos" bottle and the bottle was then placed outside the air trap. When the heat in the oven reached 150° C. the filament was connected up to a 15-volt transformer thru a variable resistance and glowed at 9 volts. Next the grid lead was connected to a 250-volt D. C. generator thru a variable resistance; the current was then turned on—the tube immediately filled with a bright blue haze—in a few minutes the grid began to get



By Using Too Small a Plate or Too Short a Filament in the Audion We Will be Limited in the Amount of Plate Current We Can Pass, as by Referring to Fig. 6 We Will Find a Point of Saturation; That is, if We Raise the Filament Temperature Still Higher the Value Ib Will Remain at a Certain Point.

(*Continued on page 266*)

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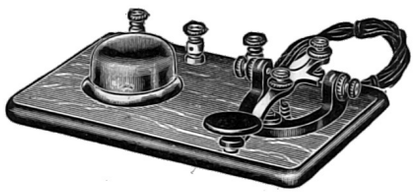

The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

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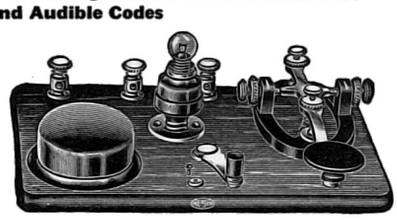

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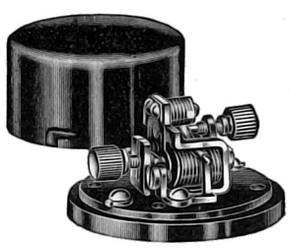

This buzzer maintains a constant note and is recommended as an exciter for checking wavemeters where pure note and ample energy are required.

It consists of practically a closed circuit field of low reluctance, having a steel armature to which is riveted a strap supporting a movable contact. The armature tension is adjustable by means of a screw with a milled head large enough to be easily and permanently adjusted with the fingers. The stationary contact is adjusted by means of a similar screw. The magnet coils are connected in series with a total D. C. resistance of 3.9 ohms. Shunted across these coils is a resistance having a D. C. value of 3 ohms. This shunt eliminates all sparking such as occurs at the break on ordinary radio buzzers and the energy saved thereby is transferred into any oscillating circuit connected to it, the result being that this buzzer as constructed radiates five times more energy than any other existing type. All connecting wires liable to be broken are eliminated. Contacts are of genuine platinum, which is essential in order to maintain a constant note. The parts are mounted on a Condensate base to insure constancy in operation.

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The Design, Pumping and Testing of Audion Tubes

By C. Murray

(*Continued from page* 264)

red hot, and soon the haze could only be seen close to the grid. Then I changed over on the plate lead and worked it a while the same way as the grid, until it became red hot. Then I went back to the grid and finished it up. I shifted to the plate again, which had a slight haze on it, so I left it on till it was "clear." Then I connected the plate and grid together and heated them with the 250-volt generator for five minutes.

I turned off the oven and removed it and allowed the tube to cool. After it was cold I glowed the filament at 7.5 volts and connected the D. C. generator to the plate lead—it became red hot and was clear, so I sealed it off the pump with a blow torch. This completes the pumping of the Audion or three-element detector.

The pumping of the Audion in this way is very necessary, especially one on which we are going to use a "B" battery of 100 volts or more—for instance, the power tube, which requires at least 200 volts before it will give much of an output.

Next we have the glowing or aging of the filament, which stabilizes the action of the filament. It allows the coating of the platinum filament to firmly fix itself to the platinum and also burns away any of the remaining gases which might be in the tube. I trust the readers can understand how their vacuum tubes are constructed after reading the foregoing.

Operate Your Audions on A. C.

By Elliott A. White

(*Continued from page* 234)

for alternating current operation is the rheostat or potentiometer R2, and the large capacity condenser C4. The rheostat has a resistance of 8—10 ohms, or other value so long as it is not too high, nor so low as to draw too much current; connections are made to the two ends, with a movable contact covering all points. The condenser C4 is made of 6 or 8 discarded telephone condensers (1 or 2 mfds. each, thoroly tested for short circuits and leaks) with a total capacity of 8—12 mfds., the higher the better, around that figure. R3 is the usual filament rheostat if one is necessary, altho it is best to design any set with as few and as "fool proof" adjustments as possible. A fixt condenser of .015 mfd., or less may be bridged across the 'phones, tho it is not indispensable. A rheostat R4 may be added for the rectifier filaments, and numerous other modifications and improvements will suggest themselves. It is theoretically possible to have only one rectifier tube, but it might be noisy, and I should want to try it before recommending it.

The operation is simplicity itself. The stept-down A. C. heats the filaments in the usual way and has been employed for this purpose before. Cheap bell-ringing transformers can be used here just as well as winding a special transformer. The *new stunt,* however, lies in using the *rectified A. C.* for the "plate." This method has already been used for *transmitter* oscillators where the noise was not prohibitive, and even then a high frequency of 2,000 was provided. But it works very well on receiving tubes, even on the usual 60-cycle house-lighting circuits, if proper precautions are taken. (It is only a natural step from the receiving set here described to an

undamped wave radiotelegraph or radiotelephone *transmitter,* operated from the handiest lamp receptacle.) It will be seen that the rectifier tubes will pass current in only one direction, that is from plate to filament, so that during each half-cycle the current from one-half of the winding T3 T4, charges the condenser C4; the side of the condenser towards the high voltage winding being always negative, and that towards the low voltage winding always positive, as indicated in the figure. It is on account of the polarity of the condenser, that separate windings T2 and T5 T6 must be provided for the filaments of detector and rectifiers. The charge accumulates on the condenser C4 as available D. C. (voltage equal to half that of winding T3 T4) and will make a hot snappy spark if the condenser is short-circuited. The need of the large capacity for C4 is to keep up the potential when current is drawn off for the detector circuits, and to reduce the pulsations from the 60-cycle A. C. The only adjustment necessary is to locate the lever H of rheostat R2 at a point on the resistance, placed across the filament, where the hum is balanced out, an adjustment which has to be made only once. It is obvious that the whole apparatus is extremely simple, as the opening or closing of main switch S (with fuses FF to protect the transformer) controls all circuits. In the hook-up indicated in the figure, the only adjustments in tuning are of the inductances, coupling and condensers in the antenna and secondary, that is, L1 (C1) L2 C2 and coupling between L1 L2, which is delicate. Amplifiers may be added and operated from the same windings. My set oscillates "like a bird" on any setting.

With *low vacuum* tubes it might be necessary to provide for adjustment of the plate voltage as these tubes are sensitive but critical in adjustment, and this can be done either by winding T3 T4 to a higher voltage than ordinarily needed and cutting it down to the proper point by means of a variable high resistance in series with the 'phones (a potentiometer across C4 would discharge the condenser); or by means of variable taps on the transformer. In case bell-ringing transformers are used for T2 and T5 T6, the latter having no tap in the middle, a rheostat may be bridged across the whole winding and the lever adjusted as in the case of R2 H.

My experience has been that the adjustment of the rheostat or potentiometer R2 H, will cut out almost all the hum of the phones in receiving, but in case local conditions produce "cross talk" in some other experimenter's outfit, he will find that by proper insulating or grounding or balancing of transformer core, case, and windings, or by reversing the supply leads where the house wiring is grounded on one side, he can get rid of any objectional noise.

In making my transformer out of an old burnt-out 1 KW pole transformer core, I found that putting the whole transformer core and windings back in the iron case was advantageous in keeping induction from the core away from the rest of the set. The entire rectifier and associated apparatus should be kept *several feet away from the receiving set,* and all leads kept short, straight and separate, as in any other shipshape and efficient outfit. Bell-ringing transformers, if used, should have metal containing cases. The most important thing in using alternating current in this way, however, is care in the tuning adjustments, as there are certain critical adjustments which will make the set "howl" on account of audible beats between local audio-frequency beats and the 60-cycle alternations, besides other causes. For example, I find that in my set, keeping within "regions of silence" from interference depends largely on exact coupling, and that I have to keep L2 above a minimum amount, and to keep C2 at a small capacity—under .00025 mfd.,

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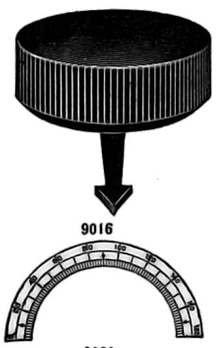

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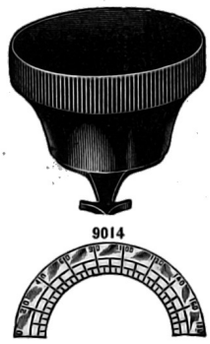

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or in the lower half of the scale on my small standard variable condenser. But I have not found the slightest difficulty in getting any desired adjustment of tuning or selectivity without starting "cross talk." A little practise is all that is necessary to make the set seem as silent as with *direct current.* Even if a faint hum still remains, it is never noticeable when fair signals are coming in, especially inasmuch as the A. C. hum is so low pitched compared with the signals, and quickly forgotten, like the scratch of a good phonograph. If anyone is unable to duplicate these results, it is his own fault. Of course a storage battery may be used for the filament, with rectified A. C. for the plate; or dry cells for the plate and a toy transformer for the filament.

This use of A. C. avoids all the bother and expense of storage batteries that cost much and require constant care and recharging; and of innumerable "plate" cells that cost a fortune now and last but a short time. The complete outfit can be constructed for the price of one "plate" battery renewal. I believe it to be the simplest and cheapest "stunt" yet.

"Hello Europe" --Via Radio

By Charles M. Ripley

(*Continued from page* 263)

the naval radio operator in Washington presses the key of his telegraphic instruments he PULLS THE TRIGGER. An instant later the effect is noted on the instruments and apparatus at the New Brunswick station 180 miles distant.

The tiny electrical impulse from Washington is used to strengthen the magnetism inside the wonderful new magnetic amplifier; and this, within the very same instant, releases the strange energy waiting inside the throbbing breast of the H. F. Alternator; and then, out on the high spun antennae flashes the AMPLIFIED dots and dashes which express the will of the American people to a listening world. So the magnetic amplifier receives minute impulses and permits terrific electric surges to enter the ether.

No device has ever equalled it for clear enunciation. There is a sharp staccato note to its messages. One way of expressing its achievement is, "New Brunswick does not slur its words."

Multiple Tuned Antennae.

A radio station without tuned antennae would be as short range an instrument as a violin without its "box" or a piano minus its sounding board. The volume of sound in each of these instruments is considerably augmented by their resonant wooden attachments, and so they can be heard at greater distances.

Just so the tuning of wireless antennae makes them "electrically resonant" with the vibrations, and augments the stations' powers of transmission.

But tuning does more than augment—it also refines the vibrations. The best comparison perhaps is that of an organ pipe.

Analogy of the Organ Pipe.

One refinement possest by the organ over practically every other musical instrument is that EACH TONE is provided with its own individual resonating pipe—separate and distinct. Since the *length* of the pipe is just ¼ the *wave-length* of its tone, it resonates only the pure tone desired. This refines the quality of the tone, as well as

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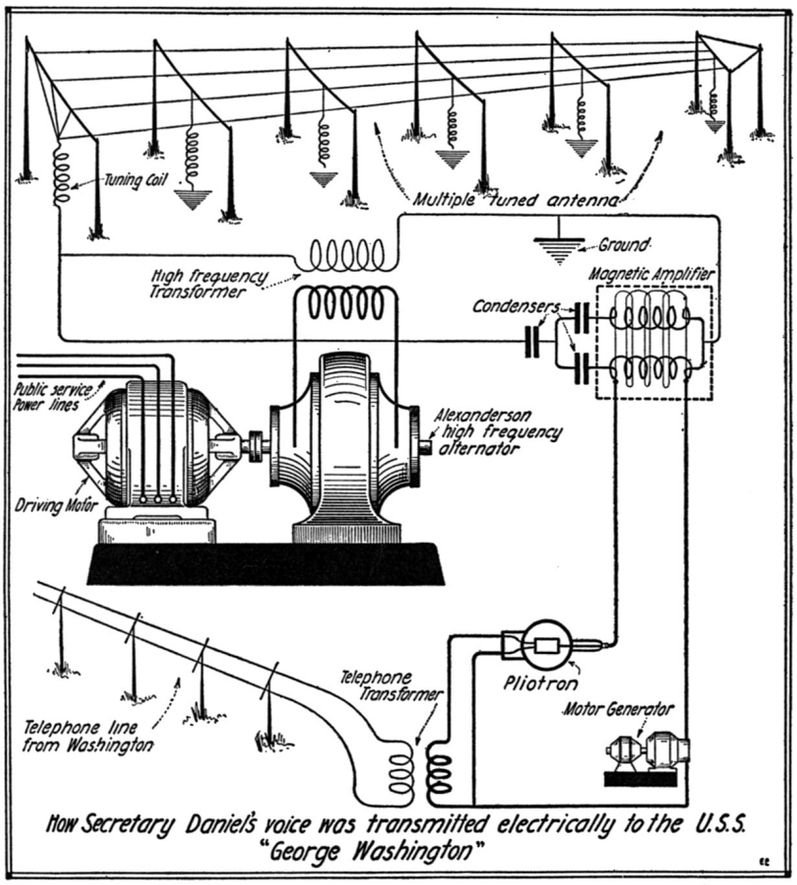

Chart-Diagram Showing the Radio Circuits at the New Brunswick Station, from Which Radio-Telegraphic and Telephonic Communication with Europe is Carried On.

amplifies its volume very markedly.

And just so the tuned antennae of a wireless station both purify as well as amplify the particular tone or vibratory frequency of the station's generator. Or putting it another way, the wires of the antennae are given electrical characteristics so that they "tingle" or "vibrate" electrically, in tune only with the particular vibrations set up by the one high frequency alternator in the station, and with no other.

Mr. E. F. W. Alexanderson explained the achievements of multiple tuned antennae as follows:

"Speaking in the simile of the organ pipe the action of the multiple-tuned antennae may be explained as follows:

"Whereas, in all previous systems the antennae may be likened to a single organ pipe, the multiple tuned antennae is six organ pipes tuned to the same pitch and sounded simultaneously in such a way that the combined sound is six times as strong as the sound emitted by each pipe. While it takes six times as much power to blow the six pipes as one pipe, the greatly increased efficiency of the new system is realized by the fact that it would require 36 times as much power to blow one pipe so strongly that it would emit a sound equally strong as the combination of the six pipes."

The six fanciful organ pipes are large "tuning coils," and as a happy by-product of their action they also serve as lightning arresters. In the accompanying illustrations these antenna tuning coils are clearly shown, as well as their relation to the antenna. One end of each tuning coil is connected to earth.

Our Heels Spark.

It was dark when we left the station, but there were two more surprises in store for me. As we walked toward the automobile under the antennae, we in the rear were astonished to *see brilliant sparks leap from the heels of those in front.* The experts explained that the electricity from the air was caught up by our bodies and discharged from our shoe nails into the ground. As an experiment one of us stooped over to touch the ground and received even a stronger shock than formerly when he stept out of the automobile that morning!

As we sped cityward, we looked back and marveled in mental perspective:

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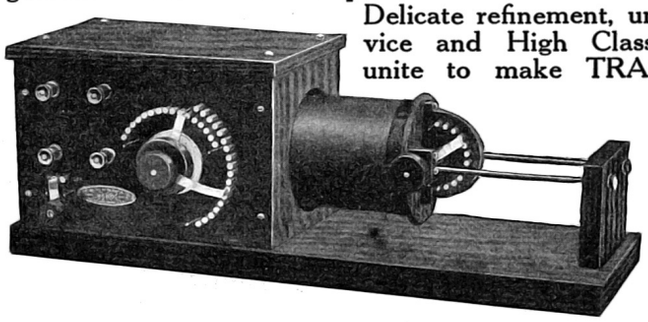

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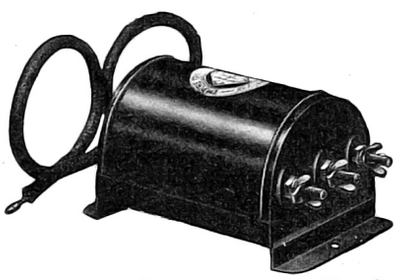

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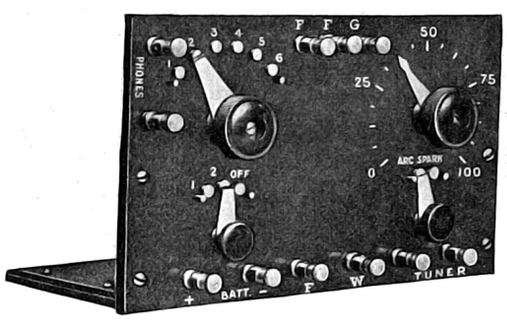

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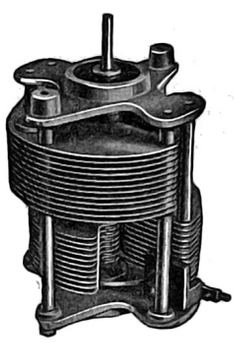

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pulses or immense power; yet small interference with other sending stations; sending 20 words per minute regularly and 90 words in test! Surely it is a privilege to live in the 20th century and to learn about these things while in the making—for many things are more interesting in their development than when fully grown to a lusty manhood.

That night the discussion of the day's visit opened up a great vision to us. A message cabled from New York to Queenstown goes to Queenstown only; but when the wireless flashes a message from New Brunswick it goes to every point of the globe simultaneously! And when we heard that it only costs $30,000 per year for power to send words to a *thousand* wireless receiving stations—then the possibilities of wireless in the future seemed to expand without limit. Here is the point: One word from New Brunswick to all the world costs—well—ask Uncle Sam! One word from New York to Queenstown only, costs 25 cents by cable.

As a whole, it may be said that the possibilities for extension of radio as a system of world communication have barely been touched upon, but the radio technique has now reached the point where it needs only capital and business initiative to duplicate and exceed in speed, accuracy and economy the trans-oceanic cable traffic; and for each sender to extend the service to all parts of

THE CALL OF W DOUBLE I

(Mr. Webster is a wireless operator at the U. S. Naval Radio Station, New Brunswick, N. J., the most powerful radio station in the United States.)

THE winter sun has settled,
Darkness is creeping near;
The moon slips behind a cold black cloud,
Denying the world of his cheer.
A sentry stands faithful to duty,
As out through the limitless sky
Crashes the call from Loyal America,
The call of W double I.
It speaks and the whole world listens,
And in the far-off city of Rome
A happy American sailor
Hears the call of his Home, Sweet Home.
It comes to the listening German,
As the Eagle's own warning cry,
And he shudders as he hears that warning,
The call of W double I.
The Frenchman hears and is comforted,
For he knows that it speaks with power;
He knows that aid is coming,
Though he knows not the day nor hour.
The load on his heart is lighter
As he settles back with a sigh;
It comes to his ear as music,
The call of W double I.
Out on the wind-swept ocean
The sailor hears the call;
He knows it comes from America,
The grandest land of all.
He grasps its high-pitched music
As it crashes through the sky,
'Tis to him as the song of the angels,
The call of W double I.
In distant cold Alaska
A soldier's eyes grow bright
As he murmurs, "Yep, that's him calling,
And he's coming good to-night."
And he sits and listens closely,
With that stern look in his eye,
For he knows 'tis the voice of Old Glory,
The call of W double I.
The moon comes out from his hiding,
And smiles his praising cheer,
On the land of Free America,
Whose call he, too, must hear.
The clouds roll away to the southward,
The stars peep down from the sky,
And the whole world stops to listen
To the call of W double I.

—H. R. WEBSTER, U. S. N.

the globe requires merely receiving stations.

New sending stations equalling New Brunswick in power would require about a half million dollars to construct and equip.

Receiving sets of a very high grade type can be purchased for less than $100 and can be installed on a table, indoors. Messages can be sent from 20 to 90 words per minute; and with a station operating over 90 per cent. of the time, SOMEONE is going to make a fortune. Or, not thinking along mercenary lines alone, why couldn't great news gathering syndicates have their own wireless systems; or other corporations with world-wide interests might have their own private plants. Perhaps the idea of John Wanamaker with his private wireless stations may be the forerunner of a series of "jitney" wireless systems by the thousands. Who can tell in these early days along what lines the development will take place?

President Wilson's Ship Fitted With Radiophone

When the *George Washington* cleared for Brest she had installed in her wireless room a telephone transmitter which permitted the President to hold wireless conversation with the Navy radio station at New Brunswick, N. J., and with Washington direct. This was made possible by the use of the General Electric Company's apparatus designed by Ernest F. W. Alexanderson.

Wireless telephone messages were sent by this apparatus to the President thruout his last voyage to France, but the steamship was not fitted with the same apparatus and he could not reply in kind. Recent experimental work, however, perfected the answering facilities, and thus made it possible for the President to "talk back" to his Washington governmental associates.

Talking Thru the Trees

By Major General George O. Squier

(*Continued from page* 204)

another tree-antenna, and automatically returned to the sender on a wire system, thus making the complete circuit. Illustrated at Fig. 6.

Long distance reception on any wave length from all the larger European stations and from our ships at sea was easily accomplished and traffic copied on a twenty-four hour schedule by the regular enlisted operators of the Signal Corps. A small portable house serving as a field laboratory was erected in the midst of the forest area on Grant Road, Washington, D. C., between the Bureau of Standards and Chevy Chase, Maryland (see accompanying illustration), and here was assembled a collection of the most efficient vacuum tube amplifiers developed to date by the Signal Corps of the Army, the Navy, the British and the French, and of commercial radio firms in the United States. With these unusual facilities it was a matter of a few days to test out, at least in a superficial manner, a large number of proposed arrangements *using trees as the antennae.*

Fig. 7 shows how a number of trees can be connected up to give the effect of one large antenna.

In France officers of the Signal Corps, by the simple device of driving a spike into a tree-trunk to which to connect the audion set which wireless operators use to magnify the dot and dash little sounds which make up wireless messages, found it was possible to "listen in" on communications between German airplanes and the German lines. Messages were thus intercepted in spots into which it would have been impossible to transport a field wireless apparatus. See Fig. 8.

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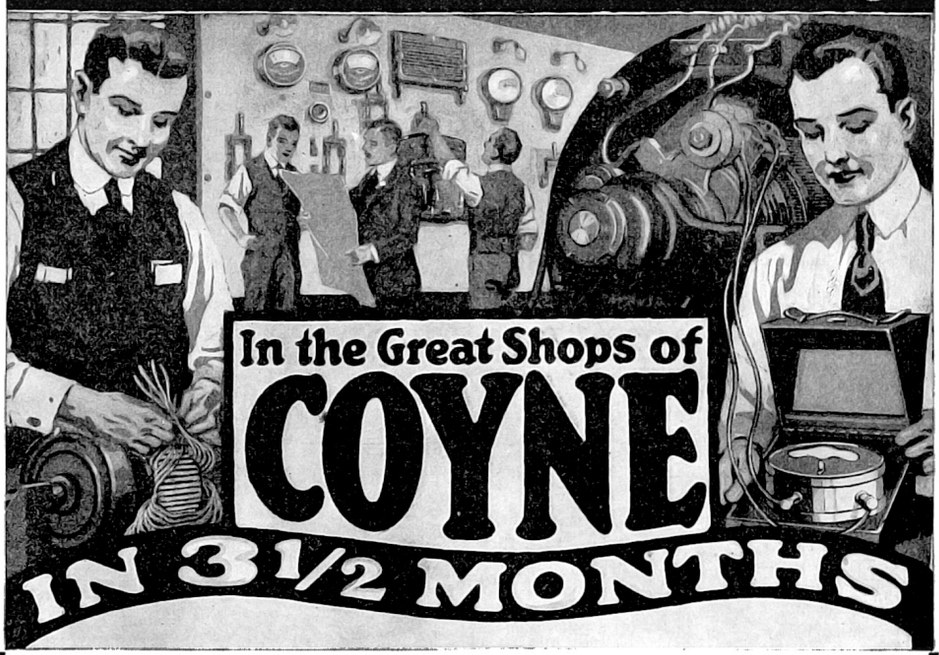

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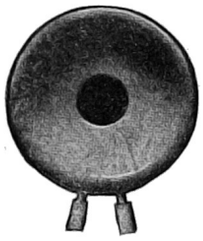

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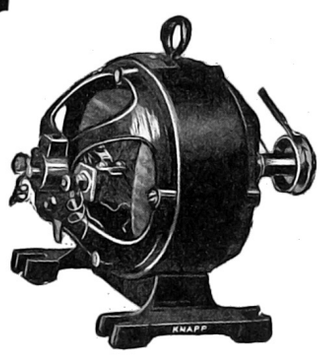

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The Physics of "Tree Wireless."

We may regard the metallic electrode rigidly driven into the living organism of a tree, as described above, as a *potential earth-terminal* for the study of the potential distribution on the surface of the earth itself. It has been shown in these experiments that this metallic terminal intimately connected to the earth itself and a part thereof is subject to changes of potential representing the innumerable frequencies required by modern radio-telephony and telegraphy, as well as any other electrical disturbances which may occur on the surface of the earth or the atmosphere above the earth.

It has been also shown, as expected, *that we can select from this composite, one or more of the different frequencies by tuned electrical loop circuits suitably connected to this electrode and study each in turn,* at will, just as color screens can select a particular component of white light. We may, indeed, by means of a highly insulated conductor bring this terminal directly to the laboratory and connect it immediately to the modern thermionic tube and amplify almost at will the particular effects we are studying. This tube (Audion) is a powerful and new instrument of research for the modern physical laboratory. Has not the physicist therefore in this electrode a means of studying in detail atmospheric and earth electrical disturbances of absorbing interest and far-reaching importance?

In short, the radio Art as a whole has attracted some of the best equipt physicists in each country as perhaps no other practical engineering subject of recent years has done, with the result that the methods and means of the radio Art are now immediately applicable and available to the physical laboratory for the study of the fundamental problems of the earth itself as a charged sphere.

For four years, under the stimulus of the World War, the efforts of engineers have been expended in producing instrumentalities for the generation and reception of radio signals and there has been little time to coordinate and assimilate the information gained into a better understanding of the ether mechanism for the transmission of electromagnetic waves thru space, over the surface, or thru the earth itself.

However, from the moment an acorn is planted in fertile soil, it becomes a "detector" and a "receiver" of electromagnetic waves and the marvelous properties of this receiver, thru agencies at present entirely hidden from us are such as to vitalize the acorn and to produce in time the giant oak. In the power of multiplying plant cells, it may, indeed, be called an incomparable "amplifier."

From this angle of view, we may consider that trees have been pieces of electrical apparatus from their beginning and with their manifold chains of living cells are absorbers, conductors and radiators of the long electromagnetic waves as used in the radio Art.

For our present purpose we may consider, *therefore, a growing tree as a highly organized piece of living earth,* to be used in the same manner as we now use the earth as a universal conductor for telephony and telegraphy and other electrical purposes.

My Early "Tree Radio" Researches.

From the account of my early "Tree Wireless" experiments I quote the following selected paragraphs:*

*Reference. "On the Absorption of Electromagnetic Waves by Living Vegetable Organism." By George O. Squier, Ph.D., Major, Signal Corps, U. S. A. Official Report to the War Department on the Military Maneuvers in the Pacific Division, 1904.

(*Continued on page 274*)

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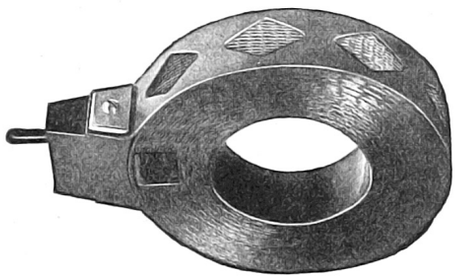

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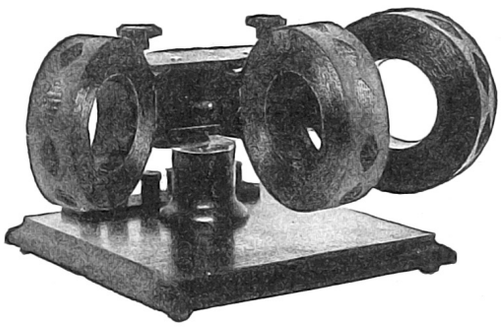

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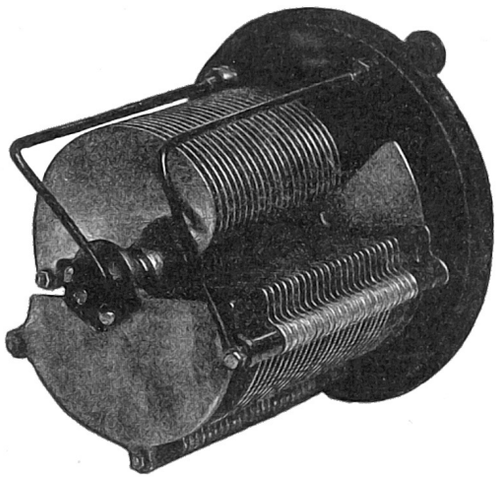

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Talking Thru the Trees

By Major General George O. Squier

(*Continued from page 272*)

"It would seem that living vegetation may play a more important part in electrical phenomena than has been generally supposed. We have seen that living vegetable organisms absorb and conduct electromagnetic oscillations over a wide range of the electromagnetic spectrum, beginning with sunlight, whose electrical action in the plant cell is at present little understood, and extending to waves of identical character, but of immensely greater lengths, such as Hertzian radiation, telephonic waves, and oscillations of the ordinary low frequencies used in commercial electric transmission lines. Disruptive discharges between vegetable electrodes, and electrostatic effects between vegetable surfaces are easily produced."

"In view of what has been accomplished in space telegraphy within the last seven or eight years, it is difficult to predict to what extent this means of communication may be ultimately developed. If, as indicated above in these experiments, the earth's surface is already generously provided with efficient antennae, which we have but to utilize for such communication, even over short distances, it is a fascinating thought to dwell upon in connection with the future development of the transmission of intelligence."

"Since a transmitting station is a central point for electromagnetic waves sent out in all directions over the surface of the earth, a large class of information, such as meteorological reports, crop reports, and general news items of interest to all, may in time be sent from central points, to be received at many places within the radius of influence of the signal station, and this, too, by the simplest forms of apparatus."

"It is seen that a growing tree, covered with foliage, is influenced inductively by electrical disturbances outside of itself, and in fact becomes generally responsive to induced electrical oscillations. It should offer, therefore, a promising means of studying meteorological effects of an electrical character, particularly those of lightning discharges, and electricity of the air. One of the first practical rules for the preservation of life against lightning is to avoid the vicinity of a tree."

"Our great forest areas may exercise an influence in maintaining a general equilibrium between the electrical charges of the upper atmosphere and the earth, which has not been fully realized. On this point, comparisons between observations from the interior of great desert areas devoid of any vegetation, with those from other portions of the earth's surface well covered with forests, would be instructive."

"From this viewpoint, the general surface of the earth may be considered as supplied by nature with innumerable meteorological observation towers, which possibly may be employed by means of apparatus involving principles already well known to science."

"In conclusion, it is believed that vegetation should be studied more systematically, from a distinctly physical standpoint than has been done in the past. Physics has been said to be the mother of all the sciences, and more and more the physical method of studying all science is proving to be the true one, as is evidenced by the great advance in recent years, in comparatively new branches of scientific work, such as Astrophysics and Physical Chemistry. Has not the time arrived for a more systematic study of Physical Botany, in the light of the new electric theory of matter?"

*Abstract of paper recently presented to Physical Society of America.

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How Don Flashed the "S.O.S."

By Mabel M. Davis

(*Continued from page 236*)

flashed out: —·—· ——— ——· —· - ·——· ——— ·—·· - "Come pole."

In five minutes Will Merton was dancing excitedly about on the sidewalk below "Don," yelling to his brothers to bring the extension ladder. Other neighbors were gathering and demanding of "Don" why he was up there. "Don" glanced about and saw no sign of the cat he had come to rescue. When the wire flashed the cat had acquired a little common sense and gone down the way it came up. So that embarrassing element of the situation was, thank Heaven, eliminated. At the next call, "Donald Johnson, what are you doing up there?" Don replied, "Fixing the transformer. Bring up my supper, will you?"

Donald's father took his place at the bottom of the ladder, steadying it while Will Merton's older brother climbed up, unhooked "Don," and helped him get a place on the ladder. At the bottom he was besieged with questions but evaded them all. Will picked up Don's loaded coat and the hungry, shivering "S. O. S." man was glad to slip into it. All he said was: "Let's get out of this before the company's trouble man gets here to splice that wire."

When he got home he confest rather shamefacedly to his father and mother and Will Merton, that he went up the pole to rescue "A cat!"

"But I've learned my lesson. No more 'cat rescue' work for me. Of all the ungrateful creatures, that beast is the limit."

Donald's parents had to admit that this was an occasion where a practical knowledge of electricity was of some use. Several of the neighbors grumbled at being in the dark for an hour, but as soon as the lights flashed on again they forgave Donald for the inconvenience.

A SERIES-PARALLEL BATTERY SWITCH

(*Continued from page 225*)

in use, all switches should be left open.

A smaller switch for taking care of a larger number of cells may be constructed by following the general proportions outlined above; each additional switch will take care of one more cell of battery. A greater number of combinations are possible the greater the number of switches used.

Contributed by ERVIN J. TROJAN.

Cells		Switch position	
Ser.	Par.	Left.	Right.
1	1	1	
2	1	4	1
3	1	2	1 4
4	1	5	1 2 4
6	1		1 2 3 4 5
1	2	1 4	
2	2	4 5	1 2
3	2	2	1 3 4 5
2	3	4 5	1 2 3
1	3	1 2 4	
1	4	1 2 4 5	
1	6	1 2 3 4 5	

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Electrical Oscillators

By Nikola Tesla

(*Continued from page* 260)

densers and operate an independent high frequency coil as customary. The controlling mechanism is of somewhat different construction but the core and contact spring are both adjustable as before.

Fig. 6 is a small instrument of this type, particularly intended for ozone production or sterilization. It is remarkably efficient for its size and can be connected either to a 110 or 220 volt circuit, direct or alternating, preferably the former.

In Fig. 7 is shown a photograph of a

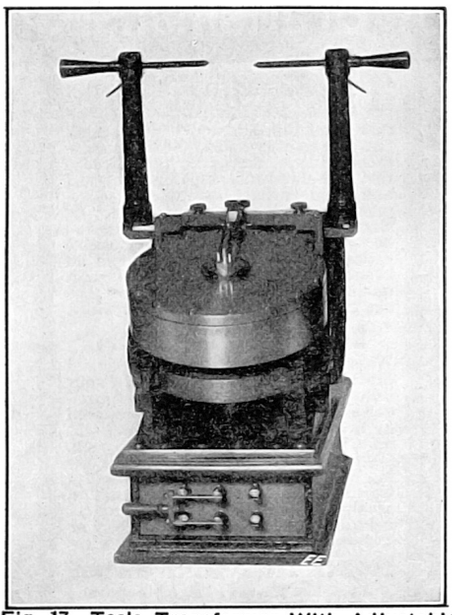

Fig. 17. Tesla Transformer With Adjustable Mercury Controller.

larger transformer of this kind. The construction and disposition of the parts is as before but there are two condensers in the box, one of which is connected in the circuit as in the previous cases, while the other is in shunt to the primary coil. In this manner currents of great volume are produced in the latter and the secondary effects are accordingly magnified. The introduction of an additional tuned circuit secures also other advantages but the adjustments are rendered more difficult and for this reason it is desirable to use such an instrument in the production of currents of a definite and unchanging frequency.

Fig. 8 illustrates a transformer with rotary break. There are two condensers of the same capacity in the box which can be connected in series or multiple. The charging inductances are in the form of two long spools upon which are supported the secondary terminals. A small direct current motor, the speed of which can be varied within wide limits, is employed to drive a specially constructed make and break. In other features the oscillator is like the one illustrated in Fig. 3 and its operation will be readily understood from the foregoing. This transformer was used in my wireless experiments and frequently also for lighting the laboratory by my vacuum tubes and was likewise exhibited at my lecture before the New York Academy of Sciences above mentioned.

Coming now to machines of the second class, Fig. 9 shows an oscillatory transformer comprising a condenser and charging inductance enclosed in a box, a transformer and a mercury circuit controller, the latter being of a construction described for the first time in my patent No. 609,251 of August 16, 1898. It consists of a motor driven hollow pulley containing a small quantity of mercury which is thrown outwardly against the walls of the vessel by centrifugal force and entrains a contact wheel which periodically closes and opens the condenser circuit. By means of adjusting screws above the pulley, the depth of immersion of the vanes and consequently, also, the duration of each contact can be varied at desire and thus the intensity of the effects and their character controlled. This form of break has given thoro satisfaction, working continuously with currents of from 20 to 25 amperes. The number of interruptions is usually from 500 to 1,000 per second but higher frequencies are practicable. The space occupied is about 10″ x 8″ x 10″ and the output approximately ½ K.W.

In the transformer just described the break is exposed to the atmosphere and a slow oxidation of the mercury takes place. This disadvantage is overcome in the instrument shown in Fig. 10, which consists of a perforated metal box containing the condenser and charging inductance and carrying on the top a motor driving the break, and a transformer. The mercury break is of a kind to be described and operates on the principle of a jet which establishes, intermittently, contact with a rotating wheel in the interior of the pulley. The stationary parts are supported in the vessel on a bar passing thru the long hollow shaft of the motor and a mercury seal is employed to effect hermetic closure of the chamber enclosing the circuit controller. The current is led into the interior of the pulley thru two sliding rings on the top which are in series with the condenser and primary. The exclusion of the oxygen is a decided improvement, the deterioration of the metal and attendant trouble being eliminated and perfect working conditions continuously maintained.

Fig. 11 is a photograph of a similar oscillator with hermetically inclosed mercury break. In this machine the stationary parts of the interrupter in the interior of the pulley were supported on a tube thru which was led an insulated wire connecting to one terminal of the break while the other was in contact with the vessel. The sliding rings were, in this manner, avoided and the construction simplified. The instrument was designed for oscillations of lower tension and frequency requiring primary currents of comparatively smaller amperage and was used to excite other resonant circuits.

Fig. 12 shows an improved form of oscillator of the kind described in Fig. 10, in which the supporting bar thru the hollow motor shaft was done away with, the device pumping the mercury being kept in position by gravity, as will be more fully explained with reference to another figure. Both the capacity of the condenser and primary turns were made variable with the view of producing oscillations of several frequencies.

Fig. 13 is a photographic view of another form of oscillatory transformer with hermetically sealed mercury interrupter, and Fig. 14 diagrams showing the circuit connections and arrangement of parts reproduced from my patent, No. 609,245, of August 16, 1898, describing this particular device. The condenser, inductance, transformer and circuit controller are disposed as before, but the latter is of different construction, which will be clear from an inspection of Fig. 14. The hollow pulley *a* is secured to a shaft *c* which is mounted in a vertical bearing passing thru the stationary field magnet *d* of the motor. In the interior of the vessel is supported, on frictionless bearings, a body *h* of magnetic material which is surrounded by a dome *b* in the center of a laminated iron ring, with pole pieces *oo* wound with energizing coils *p*. The ring is supported on four columns and, when magnetized, keeps the body *h* in position while the pulley is rotated. The latter is of steel, but the dome is preferably made of German silver burnt black by acid or nickeled. The body *h* carries a short tube *k* bent, as indicated, to catch the fluid as it is whirled around, and project it against the teeth of a wheel fastened to the pulley. This wheel is insulated and contact from it to the external circuit is established thru a mercury cup. As the pulley is rapidly rotated a jet of the fluid is thrown against the wheel, *thus making and breaking contact about* 1,000 *times per second.* The instrument works silently and, owing to the absence of all deteriorating agents, keeps continually clean and in perfect condition. The number of interruptions per second may be much greater, however, so as to make the currents suitable for wireless telephony and like purposes.

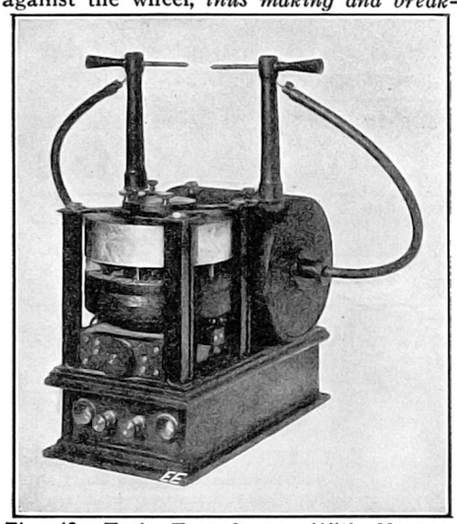

Fig. 18. Tesla Transformer With Mercury Jet Interrupter.

A modified form of oscillator is represented in Figs. 15 and 16, the former being a photographic view and the latter a diagrammatic illustration showing the arrangement of the interior parts of the controller. In this instance the shaft *b* carrying the vessel *a* is hollow and supports, in frictionless bearings, a spindle *j* to which is fastened a weight *k*. Insulated from the latter, but mechanically fixt to it, is a curved arm L upon which is supported, freely rotatable, a break-wheel with projections QQ. The wheel is in electrical connection with the external circuit thru a mercury cup and an insulated plug supported from the top of the pulley. Owing to the inclined position of the motor the weight *k* keeps the break-wheel in place by the force of gravity and as the pulley is rotated the circuit, including the condenser and primary coil of the transformer, is rapidly made and broken.

Fig. 17 shows a similar instrument in which, however, the make and break device is a jet of mercury impinging against an insulated toothed wheel carried on an insulated stud in the center of the cover of the pulley as shown. Connection to the condenser circuit is made by brushes bearing on this plug.

Fig. 18 is a photograph of another transformer with a mercury circuit controller of the wheel type, modified in some features on which it is unnecessary to dwell.

These are but a few of the oscillatory transformers I have perfected and constitute only a small part of my high frequency apparatus of which I hope to give a full description, when I shall have freed myself of pressing duties, at some future date.

The Kaiser is Canned--Can Food

By Grace T. Hadley

(*Continued from page* 219)

ples of jelly making and all the information is so clear that the work of canning and drying is no longer a mysterious problem but so simplified that school children may do it under the direction of competent teachers.

Methods of Drying.

For home drying satisfactory results are obtained by any one of three principal methods: Sun drying, drying by artificial heat and drying by air blast—using an electric fan, or other motor fan.

Sun drying has the double advantage of requiring no expense for fuel and of freedom from danger of overheating. For sun drying of vegetables and fruits, the simplest form is to spread the slices or pieces on sheets of thin paper or lengths of muslin nailed to strips of wood and expose them to the sun.

Trays should be used for large quantities. Sun drying requires bright hot days and a breeze. Once or twice a day the product should be turned or stirred and the dry pieces taken out. Care must be taken to provide protection from rain, dew and moths. During rains and just before sunset the products should be taken indoors for protection.

Drying by artificial heat is done in the oven or on top of a cookstove or range in trays suspended over the stove, or in the oven of an electric range. When drying with an artificial heat a thermometer must be used.

Air Blast—Electric Fan.

The use of an electric fan is an effective means of drying. Sliced vegetables or fruits are placed on trays and the fan placed close to one end of the box holding the trays, with the air current directed along the trays lengthwise. Insects must be kept out by the use of cheesecloth or similar material. Drying by this process may be done in 24 hours or less. As artificial heat is not used in fan drying, it is important to blanch or steam the vegetables for the full specified time. It is also necessary that all fan-dried products be heated in an oven to 180° F. for 10 or 15 minutes before storing.

Danger from Insects.

In addition to exercising great care to protect vegetables and fruits from insects during the drying process, precautions should be taken with the finished product to prevent the hatching of eggs that may have been deposited. One measure that is useful is to subject the dried material to a heat of 180° F. for from 5 to 10 minutes. By the application of this heat the eggs will be killed. Be careful not to apply heat long enough to damage the product. Store as soon as removed from oven.

Winter Use of Products.

In preparing dried vegetables and fruits for use, the first process is to restore the water which has been dried out of them. All dried foods require soaking. After soaking the dried products will have a better flavor if cooked in a *covered utensil*, at a *low temperature* for a *long time*. Dried products should be prepared and served as fresh products are prepared and served. They should be cooked in the water in which they have been soaked, as this utilizes all of the mineral salts which would otherwise be wasted.

That Wonderful Electric Action-Delayer

By Thomas Reed

(*Continued from page* 223)

ripe cantaloupe for her, but that's neither here nor there.

How about the same kind of a lock on letter-boxes? They all ought to have 'em. Put a letter in, you can, but it won't go *way* in until two minutes after you've prest a button, so you have a chance to take it back. Why, in a few years that would save more trouble than all old Bill Hoho ever made. The time you forgot to enclose the money in the mail-order. The time you just knew you'd put 'em in the wrong envelopes—and did. The sarcastic letter you wrote your wife's mother, telling her where she got off—only the place wasn't where you said, it was on your neck. Oh say, Beiler's non-mailing letter-box. Well.

Beiler himself can elaborate his invention now, all he needs is to be told what good it is. Go to it then, Al, on the biggest thing of all. Fix your machine the opposite way, so it'll *stop* something and not *let go* for those two minutes, and apply that to an electric muzzle, lip-riveter, or throat-grabber; and when you die they'll put your monument right next to Dr. Munyon's, No. 11 Benefactors' Row.

It's easy, Al, a contact just under the chin, so whenever a fellow opened his mouth to talk, he'd be muzzled, gagged, choked—or go as far as you like, rendered unconscious—for two whole minutes. Why, a guy with that apparatus on his person wouldn't have trouble enough to keep his mind occupied. Never "getting in bad," never "starting anything," always ready with those witty retorts you think of afterward, no half-baked opinions, nothing but pure wisdom. Oh hum! And if you could get your wife to wear one, think of the deep silence as you wend your way upstairs at 2 A. M., with wifie at the top struggling to get the darned thing off. Two minutes yet before she can tell you what she thinks of the poker game, and the best "thinks" of all exploding inside of her, and lost, lost!

Well, Al, I can't go on like this, I must do a little inventing myself; but you get me, don't you, and you're under full headway with your future career, yes? I'll only suggest one little handy application more, one that should be in every home, the "Safety Bargain-Shopper".

It's a common shopping-bag, containing Beiler's device, a storage battery, and a pocketbook with an electric lock. Gwendolyn sees a bargain. Instantly her hand goes into the bag for her purse, but it's locked. She presses the button of Beiler's device. Have patience, Gwendolyn, dear, in a short two minutes that filmy thing of pink batiste (is batiste right?) marked down to 79 cents, is yours. But no, Beiler is on the job, and the 79 kaplunkos are spent for one pair of fat pork chops. Does Gwendolyn change her mind? Does or rather did she have a fit of economy, prudence, far-sighted wisdom? No! Within the two minutes she is pushed away from the bargain-counter by the seething, howling mob of five thousand other bargain snappers.

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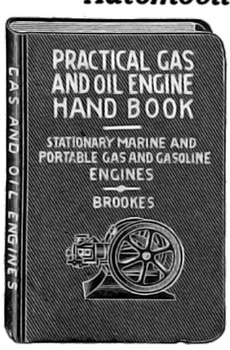

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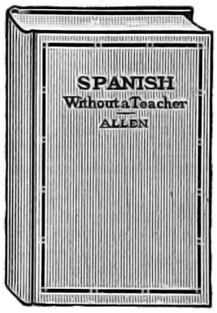

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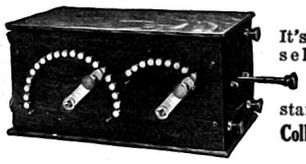

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How to Build an Astatic Galvanometer

(*Continued from page 225*)

Next make a round base for your instrument. This, too may be turned on a lathe, but may as well be made of separate disks. Make one to fit inside the other end of the chimney, and make the other about half an inch larger all around. The second disk can conveniently be beveled. Fasten the two together. Make three wooden feet for your base, and fasten them on it, letting them make an angle with each other at the center of 120 degrees. In the ends of these feet, bore holes to receive the leveling screws. The screws themselves may be the binding screws from old dry cells. If now you cut a piece of fairly hard wood (hard rubber or fiber if you have it), which will fit around the base, and be attached to two of the feet, as the diagram shows, your base is complete. This piece of wood is to hold the three binding posts.

The two coils of wire (A) need cause little trouble. Form the bobbins of heavy card-board, or, better, from thin wood, held together with glue or shellac. The size of the bobbins naturally depends on the space available inside the glass cover. Wind them with wire varying in size according to the use for which the galvanometer is intended. If you wish it to detect extremely small currents, wind it with the finest wire you have (No. 40 B & S). Fasten the coils on the base in the manner shown, taking care that, when their windings are connected in series, the magnetic field of the two will be continuous. That is, let the wire be wound in the same direction in each. Connect them in series, and bring the two leads to the two end binding posts (C). Connect the middle binding post with the connection between the two coils. This allows the instrument considerable range. If you are working with very minute currents, let them flow thru both coils. If the currents are stronger, let them flow thru only one.

The astatic element is the next consideration. Cut a light piece of wood and push thru it two steel needles, of such length, and such a distance apart, that when the whole is suspended as shown, one of the needles will swing inside the coils, and the other just above them. Before pushing the needles thru the stick that is to support them, magnetize them thoroly. Assemble them so that the *north* pole of one and the *south* pole of the other will point in the same direction. The whole element should be made as light as possible, so that it may be suspended on a silk fiber or a silk thread. Now for the actual suspension. Make a cover for the top of the test tube (see the diagram) and thru this bore a hole large enough to allow a battery binding screw to slip freely thru it. Select a binding screw with a knurled thumb nut on it, and slip it thru the hole. To its end make fast the silk thread or fiber, passing it thru a small hole in the screw itself. Let the thread be approximately the right length before assembling the instrument. By holding the binding screw firm, and turning the thumb nut, the height of the astatic element may be regulated, while if the whole screw be turned, the magnets may be brought into their proper position with reference to the coils.

Now you have a good businesslike galvanometer. You can go further and elaborate it if you like. You can experiment with different size wire, different distances between coils, and with astatic elements of different weights. You can place a circular scale on the coils if you choose, and read the values off on it with the top needle as pointer. Or you can do this stunt: Mount a small mirror on the magnet support; next take a miniature bulb and cover the glass with a coat of white paint. Let this dry, then put on one or more coats of black, or some dark color. Support the bulb and its socket on a short piece of brass tubing, as shown, or on some other support of such height that if you scratch a hole in the paint on the side of the lamp, a ray of light will be reflected by the little mirror off onto a scale which you can hold at any distance. If you do include this feature in your galvanometer, you must add two more binding posts on the base to supply current to the lamp. This stunt works fine when the instrument is to be used merely for the detection of minute currents, but remember that the magnetic field of the lamp feed wires is going to complicate matters if the galvanometer is to be used for accurate measurements. It is needless to remind the reader that with the exception of the two (needle) magnets, no iron or steel should be used in the construction of this instrument.

Musical Radio Telegraphic Sets

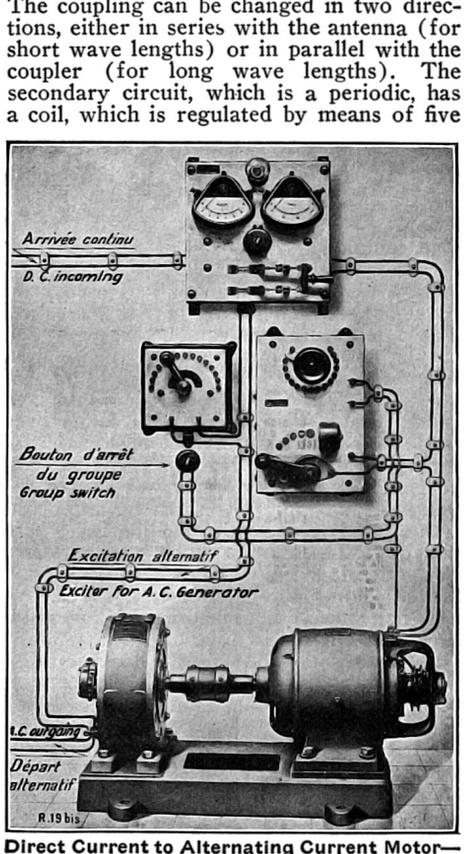
By Jacques Boyer

(*Continued from page 233*)

by means of a regulating screw.

The sending helix offers some novel points. By means of metal sliders it is possible to vary the wave lengths instantaneously. Instead of using the usual antenna switch, a special commutator is used which might be of interest to American readers.

In the sending circuit, the tuning coil has only five contacts and an air condenser. The coupling can be changed in two directions, either in series with the antenna (for short wave lengths) or in parallel with the coupler (for long wave lengths). The secondary circuit, which is a periodic, has a coil, which is regulated by means of five



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contacts for the variation of the wave length. It has the usual connections with the head receivers, and there are two detectors used, each of which can be connected into circuit by means of a switch.

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It is a solidly constructed and durable Moving Picture Machine. The mechanism is exceedingly simple and is readily operated by the most inexperienced. The pictures shown by this marvelous Moving Picture Machine are not the common, crude and lifeless Magic Lantern variety, but are life-like photographic reproductions of actual scenes, places, and people which never tire its audiences. This Moving Picture Machine has caused a rousing enthusiasm wherever it was used.

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Dept. E 9 3224 N. HALSTED ST., CHICAGO

ANARCHIST BOMBS

Consists of a little glass vial, containing in liquid form a chemical which will produce a most horrible odor. One dropped in a room full of people will cause much consternation than a limburger cheese. The smell will entirely disappear in a short time. 3 Boxes for 25c, shipped by express only, with a Dollar's worth of other merchandise.

ITCHING POWDER

This is another good practical joke the intense discomfiture of your victims to everyone but themselves is thoroughly enjoyable. All that is necessary to start the trouble is to deposit a little of the powder on a person's hand and then you can be relied upon to do the rest. The result is a vigorous scratch, then some more, and still some more. 3 Boxes for 25c, sent only by express. (Must order at least One Dollar's worth of other merchandise.)

INVISIBLE INK

The most confidential messages can be written with this Ink. Not even the writing MAKES NO MARK. Cannot be detected unless you know the secret. Invaluable for many reasons. Keeps sweethearts and other private memorandums away from prying eyes. Great fun for playing practical jokes. Only 15c Bottle

LOVE LETTER INK

Writing written with this remarkable ink vanishes entirely in a few weeks (sooner if desired), leaving the paper QUITE BLANK. 15c p. pd.

LUMINOUS INK

like fire. Quite invisible at daytime. Writing can to READ ONLY IN A DARK ROOM; writing shines bottle; 3 for 40c postpaid.

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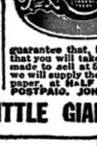
MULTIPLYING BILLIARD BALLS

The Best Feat of its Kind

This trick is as effective as it is surprising. The performer hands around the ball for examination, and immediately it is returned to him he seizes it by the tips of the roller moves the fingers and a second ball mysteriously appears. These are held in full view of the audience the by the tips of the fingers of the left hand, and even while being held in this manner another balls mysteriously appears. Final y the magician apparently suffers from some kind of spasm and yet another ball is the result. The feat can then be reversed, the balls disappearing one after another until none remains. It is a very interesting trick that is quite easily performed by following the directions that accompany the apparatus. **PRICE, 25 CENTS, POSTPAID.** JOHNSON SMITH & CO.

GOOD LUCK RING



A VERY unique and uncommon ring. It is a gunmetal Skull and Crossbone design, with two brilliant Rubies in the eyes sparkling out of the darkness in a fascinating object of interest. It is said by many to bring Good Luck to the wearer, hence its name Good Luck Ring, and whilst we will not positively guarantee it, we will give a written guarantee that, it is certainly a very unique ring that you will take a pride in wearing. They were made to sell at 50 cents, but as a special bargain we will supply them to customers mentioning this paper, at HALF PRICE, ONLY 25 CENTS, POSTPAID. JOHNSON SMITH & CO.

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Just Like Ordinary Cigarettes, But Such Real Starters.

A box containing ten apparently genuine Cigarettes. They contain a cap which explodes when about one-quarter consumed.

They appear so real, and afford as good a smoke, that the victim is taken entirely by surprise. A great laugh producer and entirely harmless. Price, box of ten, 25 cents, postpaid.

Johnson Smith & Co., Dept. E-9

THE "LITTLE GIANT" TYPEWRITER

A First Class Writing Machine For $1.25

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case of a fifty or seventy-five dollar machine. confidently recommend our Little Giant. It is so simple in construction, so that any one can quickly learn to operate it, and write as rapidly as they would with pen and ink. The letters of the alphabet most frequent y used being so grouped as to enable one to write rapidly, the numerals, 1 to 10, and the punctuation marks are also handily placed. With this machine a bright boy or girl typewri ten love letters, address envelopes, make out bills, and do almost any kind of work not requiring elaborate tabulation. With each typewriter we send a tube of ink and full printed instructions for using the machine. Price complete $1.25 by mail postpaid.

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Each box contains 12 Eggs, which are no larger than a grain of oats. When lit with a match, however, each one gradually hatches itself into a Snake several feet long, which curls and twists about in a most lifelike manner. **Price per box 10c, postpaid. Johnson Smith & Co.**

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A jointed figure of a skeleton 14 inches in height, will dance to music, perform various gyrations and movements while the operator may be any distance from it. The figure may be examined by the spectators. When handed back to the operator it is simply placed on a chair or table, when it will seemingly become endowed with life, and begin to move. At the command of the operator it will lie down, stand up, dance, etc., and send full direction with each Skeleton, for the aid of which any child can readily make it perform. 10c postpaid.

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A Great Curiosity

The Smallest Bible in the World

The Midget Bible is a perfect gem, and a work of art. It is about the size of a postage stamp and contains TWO HUNDRED AND FIFTY PAGES of the NEW TESTAMENT, profusely illustrated. This little Bible is a wonder. It is said to bring good luck to the owner. Must be seen to be appreciated. **Price, only 12 cents, three Bibles for 30 cents; one dozen Bibles for $1.00 or 100 for $6.00.** Good money can be made selling these Bibles amongst friends, church acquaintances, Sunday schools, bazaars, etc. Send for a few and try it.

The CONJURER'S CASKET

Apparatus and Directions for a Number of Mysterious Tricks Enough for an Entire Evening's Entertainment

ANYONE CAN DO THEM **50c**

It is great fun mystifying your friends. Get this Conjurer's Cabinet, and you will be the cleverest fellow in your district. It contains the apparatus for seven first-rate tricks, including The Disappearing Rose, the wherewithal on the lapel of your coat, vanishes from sight at will; the Magic Vase and Ball Trick in Wooden Ball is placed inside, and upon producing the ball only flowers are found in someone else's pocket; The Magic Nail with which you can apparently cut your finger almost in two; the Wonderful Card Trick (a card is placed in an envelope, and when opened an entirely different card altogether is found); The Disappearing Coin Box (a coin is placed in the little wooden barrel, and when opened again, is found to have vanished entirely or can be made to change into a coin of another denomination); The Famous Mesmerized Penny that defies the law of gravitation; The Glass Goblet and Vanishing Coin Trick (a coin is dropped into a glass of water, and then the water disappears, but not the coin has vanished). With the seven tricks described above we send full printed instructions for performing each trick, so that anyone can readily perform all the tricks, and great amusement of their friends or the public. Any boy of ordinary intelligence with this Cabinet of Tricks in his possession, can give a parlor entertainment not inferior to some regular magicians. Besides the tricks contained in the Cabinet, there are twenty-five other feats and illusions fully explained with full printed instructions, for which you can easily make or procure the necessary apparatus. Among them are The Mouse in a Pack of Cards, The Drawn Card, The Hat Trick, To Knock a Tumbler Through a Table, One Card Reduced to Two, To Find the Number Thought of, Mysterious Wedding Ring etc. We also send the secret of performing three wonderful stage tricks, The Art of Crystal Gazing a Woman, Walking on the Ceiling of a Room, and the Disappearing Lady, together with an article on Legerdemain, a Guide to amateur conjurers. **PRICE COMPLETE ONLY 50 CENTS.**

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A HANDSOME AND MOST EFFECTIVE WEAPON

$5.50

Measures but 4¾ inches long

Takes regular .22 calibre cartridges

The new Baby Double Action Hammerless Revolver has been produced to meet the ever increasing demand for a revolver that would combine smallness and light weight with the essential features of Efficiency and Practicability. It is small but yet is effective and serviceable as the most expensive weapon you can buy. Every lady should have a revolver and there is no time like the present to use it, and there is no safer or better one made than this. A great feature is its safety action that guards against accidental discharge, making it quite safe for young men and ladies. The illustration gives an idea of its appearance, but it must be seen and used to be thoroughly appreciated. The ammunition used is the standard .22-calibre (short) cartridge obtainable at any sporting goods store. The cartridges from us (cartridges can be shipped only by express). The revolver fires six shots in one loading. The finish of the revolver is nickel and is extremely rapid and absolutely reliable; six well aimed shots can be fired in as many seconds. It is a revolver very well constructed, with 3½ inch nickel plated fluted barrel of cylinder, and it weighs only 6½ ounces. This Prize of the Baby revolver to only $5.50, sent by mail postpaid to any address. JOHNSON SMITH & CO.

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The most wonderful and ingenious Camera made

It is but little larger than a watch, which it closely resembles. You can carry the Expo in your pocket and take pictures without any one being the wiser.

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The Expo loads in daylight with 25 Exposure Film, costing 25c, thus the picture taking part of a whole day's outing costs you only the nominal sum of 25c—One cent a picture. The Expo uses Film obtainable. It is simplicity itself to operate. Takes pictures through the stem, where the Focal Point Lens is located. The photos (5/8 x 7/8) may be enlarged to any size.

Price **$2.50**

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Time and Instantaneous shutters; weighs but 8 ounces; nickel plated. Endorsed by amateurs and professionals the world over. Thoroughly practical—Expo Exposing of films just the same as the big cameras used by the police, newspaper reporters, detectives, and the general public. Important beats have been secured with the Watch Camera by enterprising reporters. Perfect results either indoors or out. Expo negatives equal to the best in the market, size or price notwithstanding.

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Here is the Prettiest rubber stamp you ever saw. At very great cost we have had this design specially engraved for our customers, and it cannot be obtained except through us. The design is ornamental, with floral decorations, with a beautiful dove in its upper part, conveying its message of love, the desired name or name and address being tastefully displayed in the center. With this rubber stamp you can brand your letter paper, envelopes, postals and other stationery, and the elaborate design will be admired by all. Placed upon the outside of envelopes, packages and other mail matter, it ensures their return to the sender in the event of non-delivery for any reason. It looks very pretty stamped on books, music, photographs, etc. With each stamp we sell a self-inking stamp pad and a bottle of ink for re-inking the pad, and the PRICE of the COMPLETE OUTFIT, in box, is **ONLY 75 CENTS, POSTPAID.**

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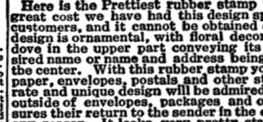

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Persons having neglected their Musical Education Need not despair, for with the aid of our new VAMPING CARD (illustrated above) and the lessons it reveals, you can at once Vamp away to thousands of Songs, Ballads, Waltzes, Rag Time, etc., etc., equal to a Professional Musician. No knowledge required. After using it a few times, you will be able to dispense with the aid of the Vamping Card entirely. **Only 15 cts. p. pd.** Johnson Smith & Co., Dept E9

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Grows to an astonishing size, the Beans measuring from 6 to 8 inches long and weighing anything from 10 to 16 lbs. and even more. One Bean is sufficient for a family for several meals. Very palatable and rich in nutritious materials. The delicate Buttery Flavor is much appreciated. The Vines are easily grown, very prolific, and a most welcome and valuable addition to the garden. Try them; you will find them the most delicious vegetable you have ever tasted. Imported direct from Colombia. Unobtainable elsewhere. Sample package of Seeds with full directions for cultivating and cooking. **25c postpaid.**

JOHNSON SMITH & CO. DEPT E9 3224 N. HALSTED STREET CHICAGO

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Sharpens the Gillette and Durham Duplex both edges at one time

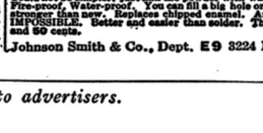
ALSO SHARPENS THE GEM JUNIOR, EVER READY, KEEN-KUTTER, HARRCROSS, CLARK, AUTO-STROP, STAR CRUSTEEL, AND ALL OTHERS

By using the SHARPEN-M-ALL STROPPER, you will not only get BETTER SHAVES, but you will SAVE MONEY and trouble. It has been found that you can get from 150 to 200 shaves from one blade, and the last shave will be just as good as the first. The construction is simple and will last a lifetime. There are no parts that can get out of order. Any novice can use it just as well as the most experienced barber. It is operated by pressing the lever or handle as shown in the illustration. It has two spiral rollers that travel from end to end of the blade, thus giving the CORRECT DIAGONAL STROKE. There are no screws, adjustments or any kind of tools necessary to operate the machine. The rollers are made of a special material that STROP AND HONE the blade at the same time. The rollers turn only one way, so there is no fear of damaging the blade or the stropper. The SHARPEN-M-ALL is packed in a handsome case, 4x2½x1½ in., with three holders and full instructions. The weight of the complete machine is but eight ounces Price, only $1.00, postpaid.

JOHNSON SMITH & CO., DEPT E9 3224 N. HALSTED STREET CHICAGO

Potmend

Stops a leak a minute



The finest repairer for Ironware, Agateware, Enamelware, etc. Good for kettles, pots, pans, boilers, and every kind of ironware, also for tin, copper, aluminum, ice boxes, iron pipes, cracks in stoves, broken china, porcelain, bric-a-brac, bisque, crockery, woodenware, marble, etc. Will not chip, fly, burn, bake or boil out. THE MEND IS THE STRONGEST SPOT IN THE POT. Could not be simpler: Just mix the powder with water. HARDENS LIKE IRON. Fire-proof, water-proof. You can fill a big hole or a small crack. Mended place stronger than new. Replaces chipped enamel. Anyone can do it: FAILURE IS IMPOSSIBLE. Better and easier than solder. Three steps, 15 cents, 25 cents and 50 cents.

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Fine black composition base suitable for detector, fixed condenser, etc. The bottom has a cavity 3" x 1½" x ⅜". Over all dimensions 4¼" x 2" x ½". Two holes for binding posts and for fastening down to table. Post paid 30c

Knob with 8/32 brass bushing, size 11/16 x 21/32. Post paid, 20c
Knob, as in upper corner, 1¼ x ¾, with hole for mounting. Post paid 20c

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9½ x 19 x ¼	Black XX	$4.00
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Talking From 'Plane to Earth

(*Continued from page* 203)

ciated distinctly to them by Lieutenant Metcalf. They craned their necks to see the 'plane soaring far above bearing the officer, whose words came down to them so distinctly thru the ether.

A few minutes later Admiral Sims, from the platform, addrest the same audience *thru the amplifier*. He praised the work of the American Army in France, saying the navy was really an auxiliary of the army. More than 100 crippled soldiers from Walter Reed Military Hospital listened attentively to Admiral Sims' address and applauded his references to the navy, every word of which was distinctly heard, thanks to the remarkable amplifying properties of the new telephonic amplifier used on this occasion.

Billie Burke, the actress, sold bonds to the audience after the address of Admiral Sims, who bought the first bond.

All of which was made possible by the use of radiotelephony on the 'plane and at the ground station, coupled to the "Magnavox," a brand new telephone amplifier thru which the crowd in front of the Treasury heard President Wilson's Victory Loan appeal. Lieutenant Metcalf of the Military Aeronautic Service, delivered the message while flying 2,600 to 3,000 feet (about one-half mile) above their heads. Altho relayed at this great height, every word of the message could be distinctly heard.

The Magnavox (i. e. magnifying voice) is the invention of Messrs. D. S. Pridham, O. B. Moorehead and P. L. Jensen of San Francisco. It was connected with the airplane by means of the wireless telephone apparatus. One of the photos shows Mr. Pridham using the anti-noise transmitter speaking to the aviator.

The first question the layman naturally asks is: "How is it done?" The effect is wonderful, to be sure, yet it seems so simple. By the aid of the accompanying illustration the successive actions taking place in transmitting the aviator's voice from airplane to earth will be understood. The uninitiated are wont to think that, by some mysterious means or other the voice itself is actually projected thru the air, and that they are actually listening to the original speech. But such is not the case. The original vocal air waves set up in close proximity to the person speaking, in this case the aviator, are imprest on a sound-sensitive instrument, known as a *microphone*.

The microphone faithfully follows every intonation of the spoken voice and modulates or varies correspondingly a weak electric current passing thru the microphone, which modulations or variations of current are caused to affect in turn an audion or "talking bottle," as it is popularly called nowadays. The modulations of current in the microphone circuit are of low or audio frequency, about 1,000 cycles per second, and when these act upon the audion the electrical condition of the circuit connected with the antenna, which is in turn connected with the audion, causes oscillations or currents of high frequency of about 50,000 to 100,000 cycles per second, or higher, which are set up and pass into the antenna. The antennæ or aërial wires from which the radio frequency energy or waves radiate on the modern airplane provides for the use of two of these antennæ, one secured at either extreme of the wings. These wires are made of the toughest phosphor bronze strands, a large number of which are cabled together to give greater strength, and at the lower end of the antennæ, which may be 100 feet or more in length, there are placed lead weights weighing about two pounds. The airplanes arise and descend to and

(*Continued on page* 283)

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The supply at this price is very limited, the price will probably be raised when my next advertisement appears, so don't delay. Fill in the coupon today—mail to me—the typewriter will be shipped promptly. There is no red tape. I employ no solicitors—no collectors—no chattel mortgage. It is simply understood that I retain title to the machine until the full $53.15 is paid. You cannot lose. It is the greatest typewriter opportunity you will ever have. **Do not send me one cent. Get the coupon in the mails today—sure.**

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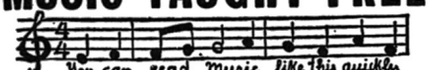

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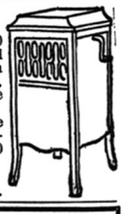

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STORAGE BATTERY TESTING

(*Continued from page 224*)

For example, a battery develops 100 amp. hours at the eight hour rate. At the five hour rate (see table) it will develop 86.5% or 86.5 amp. hours in a five hour discharge. Since amp. hours = amps. × hours, then 86.5 divided by five will = 17.3, the current in amperes that the battery will deliver for five hours.

The graphic curve, Fig. 3, showing the voltage of a pasted plate at the five hour rate will apply to any battery of pasted plates, discharged at the five hour rate.

When the battery is put on discharge readings should be taken at the following intervals: 0 hrs., ¼ hr., ½ hr., 1 hr., 2 hrs., 3 hrs., 3½ hrs., 4 hrs., 4½ hrs., 4¾ and 5 hrs. If the voltage should fall more than that shown in the curve between the 3 and 3½ hr. readings the voltage and cadmium readings should be taken at shorter intervals. When the cell voltage reaches 1.8 the pos. cadmium should read 2.00 volts and the negative about .20. Of course, these readings will vary somewhat, depending on the condition of the battery, but if the pos. cadmium falls below 1.9 volts or the negative rises above .25 it shows a lack of capacity in that group and the battery should be sent out for repairs.

A voltmeter reading on *open circuit* is of no value, since the voltage of a battery after standing a few hours is the same whether charged or discharged, approximately 2.1 volts.

Due to the fact that the *gravity* of the electrolyte changes with the temperature, the amateur very often spoils his battery in this way.

The following table will be of assistance in overcoming the above mentioned trouble. The standard temperature for all commercial testing is 70 deg. Fah.

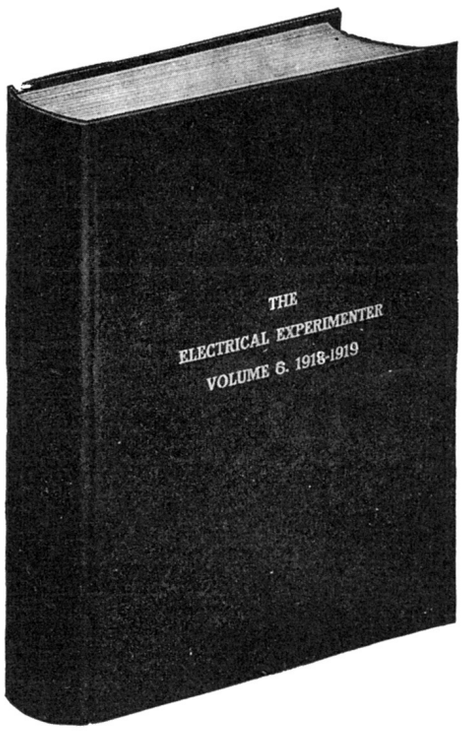
Table I

Degrees F.	Specific Gravity
100	1.275
97	1.276
94	1.277
91	1.278
88	1.279
85	1.280
82	1.281
79	1.282
76	1.283
73	1.284
70	1.285
67	1.286
64	1.287
61	1.288
58	1.289
55	1.290
52	1.291
49	1.292
46	1.293
43	1.294
40	1.295

The temperature of the battery should be kept as near 70 deg. as possible, as the capacity increases and decreases with the temperature. *A starting and lighting battery should not go above* 100 *deg. under any conditions. To do so will loosen the active material from the grids, and after a few cycles the battery will be completely ruined.* However, other batteries containing heavier plates will stand as high as 120 deg., depending on the thickness of the plates, but will be ruined if constantly operated at that temperature. It is therefore a good practise to always keep your battery below 100 deg. If it should be impossible to do this, the next best thing is to lower the specific gravity of the electrolyte.

RADIO ENGINEERS' MEETING.

The Institute of Radio Engineers held a meeting on Wednesday evening, May 7, at the Engineering Societies Building, New York City. A paper was presented on "The Detecting Efficiency of the Thermionic Detector," by Dr. H. J. van der Bijl, of the Western Electric Company. The paper presented described several different methods for measuring absolutely, or by comparison, the true detecting efficiency of vacuum tubes.



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Talking From 'Plane to Earth

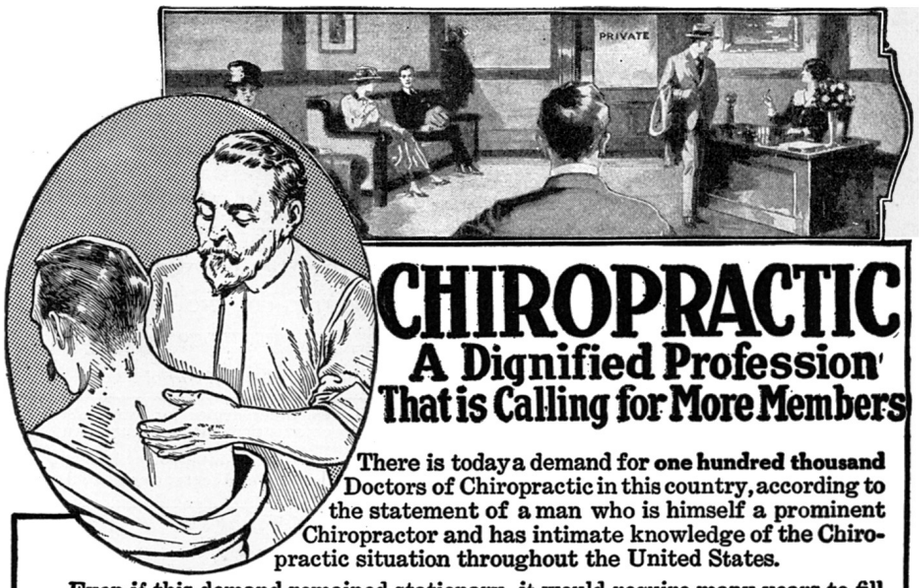
(*Continued from page* 281)

from the ground with these aërial wires outstretched. They need not be reeled up as was the previous practise.

Picking up the thread of transformations taking place in the voice from the airplane and by referring to the accompanying diagram-illustration, we see that the high frequency electric currents are shot off from the airplane antenna and proceed to set up electric oscillations or waves in the ether, *not in the air.* These waves radiate spherically in the same manner as the ripples on a small mill pond when you throw a stone into it—the ever-expanding ripples finally reaching the shore, and if a little float or tippet rests on the water it will be rocked by the wave when it reaches its position. The very same thing takes place when the aviator's voice, now transformed into extremely high frequency and inaudible waves, which may pass thru our very body or thru the building in which we may be; and these rapidly traveling waves, speeding onward with the velocity of light, or 186,000 miles per second, eventually reach the receiving antennæ, located in this case on the earth. These waves also move outward from the transmitting airplane station in all directions, and other stations may pick up the message or signals when desired, even at distances of 20 miles or more.

When in an extremely small fraction of a second the radio-telephone etheric waves reach the receiving antennæ, there are at once caused to be set up in the wires comprising these antennæ, minute electric currents corresponding in frequency to the etheric waves of, let us say, 100,000 cycles per second, which are, of course, *inaudible.* This receiving antenna, in the present instance located on the Treasury Building at Washington, D. C., was connected up with a sensitive wireless telephone receiving set, in which we find some more audions, or "talking bottles." In this case the audions or vacuum tubes containing the various electrodes for controlling the stream of electrons or minute electric charges passing thru the audion, are used inversely to their action in the airplane as described above—here they have imprest upon them the *inaudible* radio-frequency oscillations or currents coming to them from the receiving antenna and set up in the manner aforementioned. Of course, these oscillatory currents are carefully tuned by means of the usual tuning coils and metal plate condensers, so that the message comes in with maximum *resonance.* The audions transform these antenna currents into *audi-frequency* currents, which may be then past into an ordinary pair of wireless telephone receivers strapt to the head, or as in the present case, they may be past into a *sound amplifying apparatus.*

An amplifier of this type and suitable for powerfully intensifying wireless telephone or telegraph messages as well as the regular telephonic speech over the usual telephone circuits from Washington to New York, etc., is shown in the accompanying photographs and is known as the *Magnavox.* This instrument comprises a diafram and electromagnet very cleverly arranged and delicately balanced, so that when a medium strength telephone or radio current passes into it, the diafram or sound reproducer of the device responds with greatly intensified effect, and in this way it proves a wonderful advance for the purpose of public speaking, amplifying radio signals under certain conditions where more than one may wish to hear them, such as in lectures, and for a hundred and one other requirements, including train announcing, theatrical purposes, ad infinitum.



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The success of Chiropractors, in many cases, has come so quickly as to be almost startling. And yet, it is not to be wondered at when you consider the scientific accuracy of Chiropractic methods and the comparatively few Chiropractors that are now in the field.

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Radio Apparatus for Sale. Receivers, condensers, sending keys, switches, storage batteries, wall telephones, high frequency apparatus, etc. Send for list. George Holmes, 164 W. 146th St., New York City.

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Continued on page 286

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The Pliotron Oscillator

By William C. White

(*Continued from page 232*)

maximum value of about 2.5 milli-henries. They should preferably be of the variometer type, continuously variable in the range 0.5 to 2.5, altho a variation by a dozen to fifteen steps is fairly satisfactory.

The object of having L_4 variable is for the purpose of applying the high-frequency energy from the pliotron to the resonance circuit at the correct voltage, so that the energy available is used most advantageously in the resistance of this circuit.

The inductance L_3 is made variable so as to supply to the grid just the right amount of high-frequency energy to make the system self-exciting and to excite it in the most efficient manner.

As in the case of the arrangement for heavy currents, a suitable range of potential for the direct-current source is from 200 to 750 volts.

With such values of inductance and capacity that a frequency of 100,000 cycles is obtained, a voltage of 12,000 may be produced from one pliotron tube operating from a direct-current source of 500 volts.

Pliotron tubes may be operated in parallel for the production of a voltage higher than that obtainable from a single tube.—*Photo Courtesy G. E. Co.*

BATTERIES LIGHT HOUSES IN SWEDEN.

A recent fair held in Sweden brought out the shortage of oil and the many substitutes and methods of economy displayed. The efforts of the lighting industry to find a substitute for the kerosene lamp were shown at the fair in the form of carbid lamps for use in places where there is no electric current—a battery lamp called the "Mercal," and also the Jungner primary elements intended for the electric lighting of entire buildings.

This Is How We Look in Arabic

(٢٣٥) الروضة

بسهولة من سكان الزهرة بمساعدة التلسكوب الذي نستعمله نحن هنا لرصد السيارات

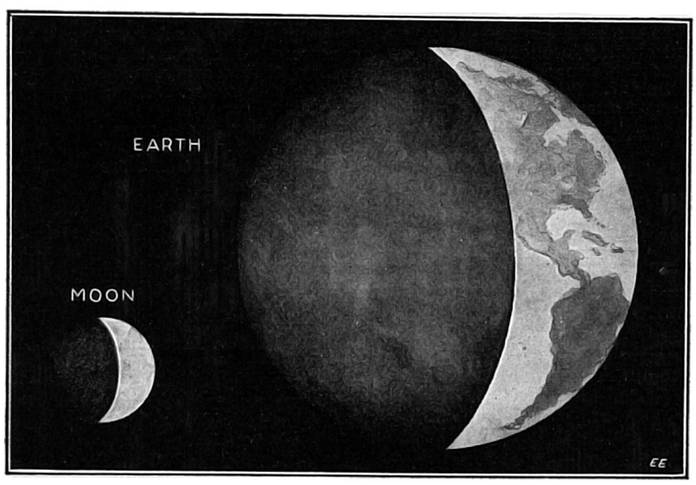
فمتى كان المريخ في مركز مناسب للرصد عن الارض يكون قطر الدائرة من قرصه

ما بين خمسة عشر او خمسة وعشرون ثانية من القوس حسب تعديل مسافته عن الارض

في اوقات الرصد وعندما تكون الارض بنقطة موافقة لرصدها من الزهرة فقطر دائرة قرصها

يكون ثلاثة وستون ثانية من القوس وقطر دائرة القمر سبعة عشر ثانية من القوس وحتى

ان قرص القمر الذي نراه فانه يبان للزهرة في اوقات خصوصية اكبر مما يبان قرص المريخ



Articles from the ELECTRICAL EXPERIMENTER Have Been Reprinted in Almost Any Language You Could Think of. Last Month, However, Was the First Time That We Were Quoted in an Arabian Publication. We Reprint Herewith Mrs. Lewis's Article "The Planet Earth" Taken from "Ar-Raudat" — (The Meadow), a Semi-monthly Arabian Magazine, "Ar-Raudat" Republisht the Entire Article from Our April, 1919 Issue.

(الرسم الرابع)

هذا الرسم يظهر هيئة الارض كما تبان للمريخ في وقت لمعانها وهي بهيئة هلال ولزيادة

التوضيح انظر شكل ٢ وه فالارض لا تظهر لسكان المريخ الا كما هي ظاهرة في هذا

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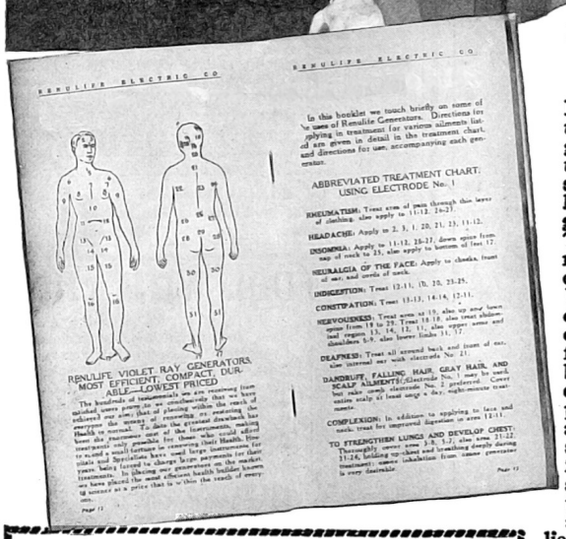

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- Neuralgia
- Neuritis
- Obesity
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- Pimples
- Pyorrhea
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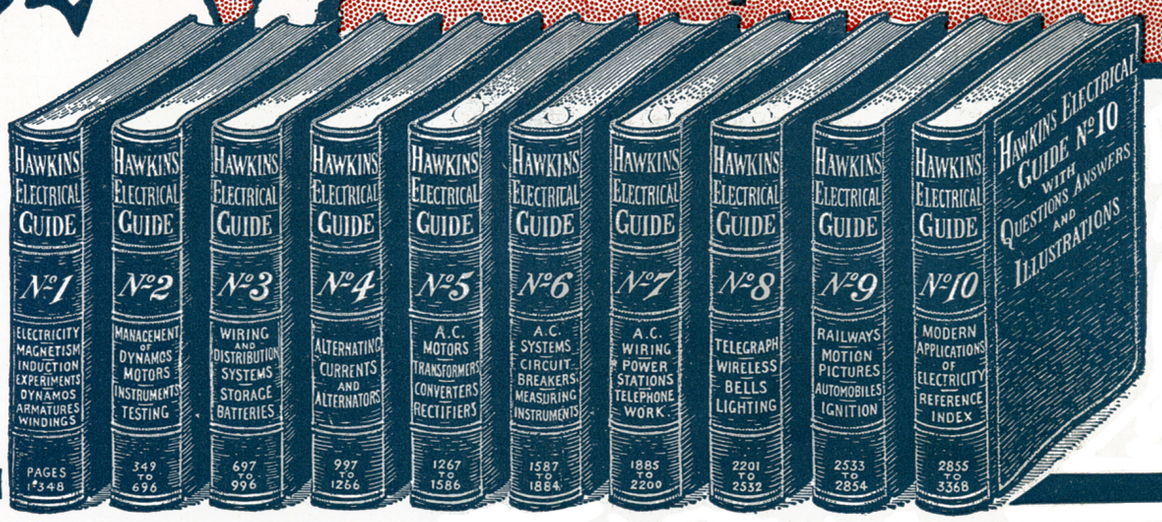

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